THE

CHEMICAL NEWS

AND

JOURNAL OF INDUSTRIAL SCIENCE.

WITH WHICH IS INCORPORATED THE "CHEMICAL GAZETTE."

A Journal of Theoretical and Practical Chemistry and Physics,

IN THEIR APPLICATION TO

ENGINEERING AND MANUFACTURES.

EDITED BY

J. G. F. DRUCE, M.Sc. (Lond.), R.Nat.Dr. (Prague).

278
30 AUG 1924

VOLUME CXXVIII. 1924.

LONDON.

PUBLISHED AT THE OFFICE, 97, SHOE LANE, E.C.4.

AND SOLD BY ALL BOOKSELLERS.

1924.

LONDON:
PRINTED BY REA, WALKER & INCHBOULD, LTD.,
224, BLACKFRIARS ROAD, S.E.1.

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THE CHEMICAL NEWS.

VOLUME CXXVIII.

Edited by JAMES H. GARDINER, F.Inst.P., F.C.S., and
J. G. F. DRUCE, M.Sc. (Lond.), R.Nat.Dr. (Prague), &c.

No. 3325.—JANUARY 4, 1924.

... AND RESEARCH ... 25 APR 1927 ... COIMBATORE

THE PREPARATION OF PURE MANGANOUS CHLORIDE FROM CHLORINE RESIDUES.

By W. Smith, B.Sc., A.I.C.

One of the inorganic preparations described in many textbooks is that of "pure manganous chloride"—made by the purification of chlorine residues. It is given, for example, in Roscoe and Harden's "Inorganic Chemistry for Advanced Students"; in Lowson's "Preparations and Exercises in Inorganic Chemistry"; and in such modern books as Blanchard and Phelan's "Synthetic Inorganic Chemistry," as well as such old ones as Attfield's "General, Medical, and Pharmaceutical Chemistry."

In all cases the aim is to remove the ferric chloride resulting from the ferric oxide, which invariably contaminates the original pyrolusite; and always the same method is recommended. The solution, assumed to contain $FeCl_3$ and $MnCl_2$, is digested while hot and with stirring, for some hours with $MnCO_3$. The iron is then precipitated as a result of the following reaction—

$$3FeCl_3 + 3MnCO_3 = Fe_2(CO_3)_3 + 3MnCl_2,$$

followed by the hydrolysis of the unstable ferric carbonate—

$$Fe_2(CO_3)_3 + 3H_2O = 2Fe(OH)_3 + 3CO_2.$$

When a sample of the filtered solution no longer gives a black precipitate (FeS) with ammonium sulphide, or a blue coloration (Prussian blue) with potassium ferro-cyanide, all iron has been removed. The main bulk of the solution is filtered, and the pink filtrate evaporated down. Pure crystalline, $MnCl_2.4H_2O$ results—so it is said. The point of the reaction utilised is, of course, that while the iron (and any aluminium) is precipitated and may be removed, no extraneous soluble product is simultaneously introduced to contaminate the manganous chloride.

Two comments may be made on this preparation:

(1) The author has, in spite of repeated trials, never yet succeeded in completely removing iron by this method.

(2) Assuming that it is possible to remove iron and aluminium by this method, no attempt is made to remove calcium, invariably present in pyrolusite, or any other impurity.

The pyrolusite used in all these experiments contained:

SiO_2	4.00 p.c.
Fe_2O_3	3.16 p.c.
P_2O_5	0.24 p.c.
Al_2O_3	2.29 p.c.
CaO	1.62 p.c.
MnO_2	88.65 p.c.
Total	99.96

These figures are the average of two complete analyses on samples of the ore dried at 105°.

During the work hereafter described, a trace of nickel was discovered.

Molinari says that pyrolusite may contain:

SiO_2	up to 20 p.c.
Fe_2O_3	up to 30 p.c.
P_2O_5	up to 1 p.c.
Al_2O_3	up to 8 p.c.
CaO	up to 4 p.c.

and from 30-90 per cent. MnO_2.

In two formal tests of the above method the following procedure was employed:—

The filtered chlorine residues, an orange-yellow liquid, is evaporated to dryness in a large porcelain basin, and the mealy orange solid gently ignited while being constantly stirred. The temperature is raised, but must not reach dull redness, nor be unduly prolonged, or chlorine is driven from the $MnCl_2$ also, and some of the manganese rendered insoluble and lost. In this way any dissolved silica is rendered insoluble, and a great part of the iron is converted into insoluble basic compounds. The P_2O_5 will be combined with the basic oxides as insoluble phosphates. The brown-grey mass is cooled, extracted with boiling water, and filtered. That little iron is now left may be deduced from the fine pink colour of the filtrate. One-tenth of this liquid is taken, diluted, boiled, and excess of sodium carbonate solution added. The precipitated $MnCO_3$, after thorough washing, is added to the remainder of the pink solution, and the mixture kept hot and frequently stirred for about 10 hours. On testing a few ccs. of the filtered liquid, iron was distinctly indicated. The whole was, therefore, filtered; one-tenth of the filtrate again taken, precipitated as $MnCO_3$, and the digestion repeated as before. Even after this, iron was still found in solution.

In the second test, one-ninth of the pink filtrate (after the ignition and extraction) was precipitated, and the washed $MnCO_3$ digested with the remaining eight-ninths, for a week, night and day, at a moderate heat, being frequently stirred throughout the day. Some iron is undoubtedly removed, as the cream colour of the $MnCO_3$ becomes a distinct buff. Nevertheless, when the whole solution is filtered, heated, and two or three drops of ammonium sulphide added, a black precipitate is thrown down. The precipitant is slowly added until the buff of the MnS is distinctly apparent. To put the matter beyond any doubt (for the black precipitate may be NiS or CoS as well as FeS), the precipitate is filtered off, dissolved in hot HCl, filtered, boiled and precipitated with slight excess of NH_4OH. A reddish precipitate was given, which, on solution in HCl, gave all tests for iron. Nickel was tested for in the ammoniacal filtrate with dimethyl glyoxime. Very distinct traces were, rather surprisingly, given; but it must be remembered that a solution corresponding to about 50 gms. of pyrolusite was being treated.

It appears, therefore, that neither the iron, probably not the aluminium, and certainly not the nickel nor the calcium are removed by this method. (The calcium may readily be detected in the filtrate, after all Mn has been precipitated as MnS, by the addition, hot, of a solution of ammonium oxalate.)

All these impurities may definitely be removed in the following manner:—

Boil the original pink filtrate (after the ignition and extraction), and add slowly ammonium sulphide, until the impurities (Fe, Al, Ni, and any CO) have all been precipitated and the buff of the precipitated MnS is quite clearly seen (the solubility product of MnS is much larger than those of FeS, $Al(OH)_3$, NiS and CoS, hence these substances are all precipitated before any MnS appears). Boil well, allow to settle, and filter. The filtrate contains $MnCl_2$, $CaCl_2$, and NH_4Cl. Evaporate down to near dryness, and cautiously add a large volume of concentrated HNO_3. Boil well (under hood) and again evaporate down to near dryness. Repeat treatment with HNO_3 two or three times. All NH_4Cl is now destroyed, and Mn is present as $Mn(NO_3)_2$, and all Ca as $Ca(NO_3)_2$. Evaporate down and ignite under hood in a porcelain basin. MnO_2 and CaO remain. Grind up the black mass and boil with dilute HNO_3, and finally with distilled water. Pure MnO_2 remains, and from this pure $MnCl_2$ or $MnSO_4$ may be prepared.

It should be noted that pure MnO_2 (really H_2MnO_3) cannot be precipitated from solutions of $MnCl_2$ containing $CaCl_2$ by treatment with NaOH followed by oxidation with Cl or Br. In such cases, some of the calcium is CO-precipitated probably as calcium bimanganite, $Ca(HMnO_3)_2$.

The whole preparation forms a most interesting and instructive exercise for the fairly advanced student.

THE INSTABILITY OF CUPRIC HYDROXIDE.

By G. Fowles, B.Sc., A.I.C.

Besides the familiar blue gelatinous form of cupric hydroxide obtained by precipitation with caustic alkalis, it is known that a stable crystalline variety exists.

This may be prepared in slightly varying ways, and has been described by Becquerel (1852), Böttger (1858), Peligot (1861), Van Bemmelen (1894), and Bonsdorff (1904).*

The preparations most frequently referred to in the literature are those of Böttger, Peligot, and Van Bemmelen.

The most satisfactory method of preparation is first to obtain a basic salt in a crystalline condition, and then decompose it with a cold 10 per cent. solution of caustic soda. Böttger prepared a basic copper sulphate by adding less than the equivalent of ammonia to a boiling solution of copper sulphate. Van Bemmelen used a basic copper nitrate obtained by digesting a solution of the normal salt with sodium acetate. The procedure of Peligot was to precipitate cupric hydroxide directly by diluting various ammoniacal copper solutions with much water.

The stability of these crystalline varieties is remarkable. The preparations of Van Bemmelen, Böttger, and others can be heated for a long time at 100°, either alone or in water, without suffering change of colour or composition. The behaviour of the preparation of Peligot is anomalous. It remains unchanged in colour for many hours at 80°, but at 85° passes into a beautiful green form without loss of water; at 100° it becomes olive green before slowly darkening and dehydrating. Now this modification of cupric hydroxide contains ammonia, which is not removed even by long washing, and (as will be shown later) it is highly probable that this accounts for its abnormal behaviour.

As is well known, the gelatinous form slowly in the cold but rapidly at 100° passes into the dark amorphous powder conventionally called copper oxide, but actually a hydrated oxide of indefinite composition to which various formulæ have been assigned, such as: $7CuO,H_2O$; $3CuO,H_2O$. When the well washed gelatinous hydroxide is allowed to stand in ice-cold water, it passes into the crystalline variety.

A suspension of the gelatinous hydroxide in dilute solutions of certain salts, such as manganese sulphate, can be heated to 100° without darkening; actually under these conditions the gelatinous safely passes into the granular form. This so-called stabilisation of the hydroxide has been attributed by Bancroft to the oxide of the added salt being absorbed and acting as a protective colloid.*

In his recent paper on Hydrous Cupric Oxide (*J. Phys. Chem.*, 1923, XXVII., 501), Weiser shows that the hypothesis of Bancroft† is untenable, and replaces it by one of his own. In this paper Weiser's explanation is in turn examined and rejected and a more simple one is suggested.

Weiser found that whereas dilute solutions of some salts prevent the blackening of the gelatinous hydroxide, others have no effect or accelerate it.

He noticed that those salts which acted as stabilisers have an acidic reaction and consequently a small concentration of H-ion due to hydrolysis, hence he assumes they exert a slight solvent action on the copper hydroxide; a behaviour not possible with such salts as sodium sulphate, which hastened the blackening. On this he bases his hypothesis, having elsewhere shown that a gelatinous precipitate may be destroyed and its particles agglomerated into denser clumps by a substance having a slight solvent action.

The experimental result on which he most relies, both to discredit the hypothesis of Bancroft and to support his own, is the stabilisation by means of a solution of copper sulphate. In his own words, "It is inconceivable that the absorption of blue hydrous cupric oxide should stabilise blue hydrous cupric oxide."

The possibility of the whole amount of copper hydroxide uniting with copper sulphate to form a stable basic salt he dismisses as "altogether improbable," for it would have the composition $20CuO.SO_3$; he seems unaware that Pickering (*Journ. Chem. Soc.*, 1909, XCV., 1417), who made a life long study of basic and complex copper salts, towards the end of his career described the compound $15CuO.SO_3$. That a protective layer of basic salt may form he likewise rejects, because basic salts form in certain conditions by the interaction of copper hydroxide and alkali salts, and these hasten the blackening.

It may here be pointed out in advance that Weiser completely overlooks the influence of the alkali present in the copper hydroxide he used. The action of copper sulphate and similar salts is thoroughly to remove this as very insoluble basic salt; alkali salts either exert no action or increase the amount of soluble hydroxide.

* *A good bibliography of cupric hydroxide is to be found in Mellor's "Treatise on Inorganic Chemistry," Vol. III., p. 148.*

† *Only references which are not found in Weiser's paper are given here.*

On the following grounds the hypothesis of Weiser is held to be untenable:—

1.—Other solvents which exert a slight solvent action on copper hydroxide, such as sodium hydroxide, accelerate the darkening.

2.—The so-called small amounts of added salts were not trifling when their action is considered, and varying molecular quantities were required to produce the same effect: thus for 20 formula-weight parts of cupric hydroxide, 1 of copper sulphate sufficed, whereas 1.5 of copper chloride were required, and 3 of cobalt chloride were scarcely sufficient. Now cupric chloride would form the compound $CuCl_2.3Cu(OH)_2$, so that 1.5 parts of cupric chloride would account for almost a quarter of the copper hydroxide present.

3.—But the most cogent reason is that no such continuous solvent action as Weiser imagines can possibly go on: the following experiment convincingly shows this:—

When a slight excess, *i.e.*, more than sufficient to form the compound $CuSO_4.3Cu(OH)_2$, of freshly prepared crystalline cupric hydroxide is added in the form of a cream to a boiling dilute solution of copper sulphate, the blue colour of the hydroxide instantly changes to pale green as it enters the liquid, owing to the formation of a basic salt of reputed composition, $CuSO_4.3Cu(OH)_2$: on immediately filtering the liquid no copper can be detected in solution, even by potassium ferrocyanide. From this experiment it is obvious that no such continuous solvent action as Weiser imagines can possibly go on; after the first second his material was merely heated in water.

The above experiment will also serve to point out an erroneous interpretation of an experimental result which occurs in another paper dealing with the subject under review.

In a paper on Peptisation and Precipitation (*Trans. Faraday Soc.*, 1921, XVI., appendix, 122) Chatterji and Dhar, discussing the change of the blue hydrated copper oxide into the black form, say, "If the black hydrated copper hydroxide is boiled with a little copper sulphate solution, a reversible change takes place, the blue precipitate $[Cu(OH)_2]$ reappearing." What was seen here was obviously the pale green basic salt, $CuSO_4.3Cu(OH)_2$, which has been mentioned several times in the literature as forming under such circumstances, *e.g.*, Sabatier (*Compt. Rend.*, 1897, CXXV., 301).

The hypothesis of Weiser must be discarded, since it is based on a reaction which is illusory; a simple explanation is offered in its place, born of the following considerations:—

The crystalline variety of cupric hydroxide (Böttger's), on being kept at ordinary temperature, becomes discoloured; although this is scarcely perceptible at the end of a year it is patent in a preparation two years old. [Dawson, who used Böttger's preparation in his work on ammoniacal copper solutions, also noticed this. In a footnote to his paper (*Journ. Chem. Soc.*, 1909 XCV., 172), he says, "Specimens not apparently changed at the end of one year had all undergone pronounced colour changes at the end of two or three years."]

Preparations (Böttger's and Peligot) made several years ago and left owing to the incidence of the war, have considerably darkened in colour; those ten years old are now of a bluish slate tint, whilst one (since lost), at least twelve years old, was quite black. These changes had not been anticipated. The substances were stored in tubes, corked to be secure and dust free, no attempt having been made to render them air-tight so that no incontestable argument can be based on their present water content; but compared with material made under similar conditions about the same period and analysed at the time of preparation, a specimen eight years old shows no loss of water, whilst one ten years old has lost 2 per cent. The latter, a slate coloured substance, is now in a peculiarly sensitive condition. Although it remains unchanged in colour after being heated to 100° for over an hour, it goes quite black in a few minutes if immersed in boiling water. When moistened with dilute sulphuric acid (2N.) it darkens instantly, apparently passing into the brown black hydrated copper oxide before dissolving. A similar phenomenon occurred when dilute hydrochloric and nitric acids were used, more slowly when solutions of ammonium sulphate and ammonium chloride were employed. In ammonium hydroxide and in a mixture of glycerol and sodium hydroxide it dissolved without change of colour.

The substance may be a mixture of blue and black hydrated copper oxide, of which the blue form is the more soluble, or what seems more probable, the acid instantly completes the transformation to the stable dark hydrated oxide. Allmand (*Journ. Chem. Soc.*, 1909, XCV., 2154) has shown that blue crystalline copper hydroxide in

contact with N. potassium hydroxide solution at 25° is slowly blackened, forming the indefinite hydrated oxide, $CuO.xH_2O$; N/7 ammonium hydroxide produces the same effect in several weeks.

From these observations it is obvious that the crystalline hydroxide is very slowly going through those changes which are so rapid in the gelatinous variety, that the intermediate stages are not seen, and that in each case the changes are accelerated by soluble hydroxides. The crystalline variety must therefore be regarded as a highly stable intermediate form in a state of suspended transformation.

Incidentally, ammonia, combined or adsorbed, must act as a specific catalyser promoting the formation of the green isomeric form obtained by Forcrand, as already mentioned: for, some years ago, wishing to obtain copper hydroxide quite free from caustic alkali, I prepared a crystalline basic copper sulphate and treated it with ammonia solution of density 0.880. The resulting copper hydroxide retained its fine blue colour when heated at 100° for half-an-hour, it then deepened in tint without discolouring, and slowly changed to greyish-green. This preparation, like that of Peligot's, contained a small amount of ammonia which could not be removed by washing with water.

Now it is maintained that the gelatinous copper hydroxide used by Weiser contained sodium hydroxide absorbed or combined, and that the hot salt solutions he added effectively removed this as insoluble basic salts; thus the stabilisation consisted in removing a catalyser and allowing the unstable gelatinous substance safely to pass into the more stable crystalline form. Weiser prepared his gelatinous hydroxide by mixing (at 5-8°) N/10 solutions of sodium hydroxide and copper sulphate, and washing once with water, centrifuging throughout.

Pickering (*Journ. Chem. Soc.*, 1907, XCI., 1982) states that when cold dilute sodium hydroxide is added to a solution of copper sulphate, the basic salt, $CuSO_4.3Cu(OH)_2$, is formed first, and is only slowly converted by dilute alkali to $CuSO_4.4Cu(OH)_2$, then to $CuSO_4.9Cu(OH)_2$, and finally to the normal hydroxide. Pickering arrived indirectly at the composition of these precipitates from the sodium hydroxide used and the copper removed from solution, hence any combined alkali would have been missed.

Jordis (*Zeit. fur elektrochemie*, 1912, XVIII., No. 13, p. 553) states that the basic salt formed when caustic soda is added to copper sulphate solution always contains caustic soda not removable by washing; up to the addition of 0.8 equivalents of caustic soda, it has the composition 1Cu : $0.8SO_4$: 0.05Na, and even when 1¼ equivalents of sodium hydroxide have been added, the precipitate still contains sodium cuprate.

It is unfortunate that Weiser does not give an analysis of his copper hydroxide—the chief ingredient in each of his many experiments—it seems reasonable to assume that it contained sodium hydroxide: that his stabilising substances successfully removed this finds abundant support from a survey of his experimental results. In every case in which the stabilisation was successful, a substance (manganese sulphate, copper sulphate, sulphuric acid, etc.) was added, which would very thoroughly remove a soluble base, while it is significant that sodium sulphate and suspensions of colloidal metallic oxides, etc., which have no such power, either had no effect or hastened the blackening. That traces of substances would not suffice, but that small and varying amounts of added salts were required to produce the same effect gives some measure of the amount of sodium hydroxide present, and also perhaps of the ability of the added salts to form basic salts and of the varying composition of these.

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ARE THE NATURAL GROUPINGS OF THE ELEMENTS AND THE SPECTRAL LINES OF HYDROGEN RELATED?

PARTS VII. (*continued*), AND VIII.

BY F. H. LORING.

In this series of papers—see *The Chemical News*, 1923, CXXVII., pp. 225, 257, 273, 290, 337, 355, 369, 386—an attempt has been made to prove that from the spectrum lines of hydrogen a set of figures are derivable which agree with the periodic table groupings, and the radical positions in the planetary and satellite groupings.

Although it is admitted that taking the

evidence of a single set of relations, like those of the satellites of Uranus, is not sufficiently convincing, the cumulative results are such as to rule out any possibility of chance coincidences. Since experimental values are used throughout this study, the possibility of coincidences, due to *ad hoc* hypothesis, are eliminated absolutely.

As a suggestive outcome of these studies the idea is advanced that the electron only vibrates in various stable radial positions relative to the atomic nucleus, whilst then —*i.e.*, during each practically stationary state—it gives rise to a radiation that forms essentially a circle or ellipse round the nucleus as the centre, very much as Hertz waves encircle the earth. This conception helps to remove a number of outstanding difficulties common to existing theories of the atom. For example, it reconciles the Rutherford-Bohr atom with the Lewis octet theory; the magnetic tangle, so to speak, is avoided; the quantum emissions and adsorptions, as revealed spectroscopically, are easier to comprehend; the difficulty of an accelerating electron not emitting radiation is removed, since in reality the radiation is closed round the positive nucleus of the atom and then supports, as it were, the vibrating electron (the action may be mutual) which can only give out radiation when it settles into a new but definite radial position in accordance with Bohr's theory—except that the electron does not describe circular or elliptical orbits (excluding the case of highly magnetised bodies, which is another distinct phenomenon).

This type of atom and its behaviour in respect of radiation phenomena may be illustrated on a planetary scale by considering the earth and its single satellite—the moon—representing respectively the positive nucleus of the hydrogen atom and its distantly situated electron.

Consider such a system not in rotation and in place of gravity, the negatively charged moon being attracted to the positively charged earth, but the law of attraction in this case represented, or modified, according to an equation suggested by Sir J. J. Thomson (see the writer's "The Chemical Elements," p. 161). Consider the moon vibrating along a radial line extending from the earth, so as to set up a wave in the ether normal to this line, and which describes a circular path in space round the earth. No radiation would pass out from this world system into the stellar systems beyond until the moon was suddenly displaced to a new radial position, say one represented by that of Mimas with respect to Jupiter, where it could again vibrate without giving out an expanding-like radiation. The original radiation would then leave the earth-system as a definite bundle, and pass out into stellar space, and, in so doing, obey the laws of electromagnetic radiation.

With the poet one may exclaim, "That things should spin, for ever spin, down to the smallest thing, is truly marvellous!" but in this case the "smallest thing" is, in one sense, the *radiation* and the "spin" is the *circulation*.

Returning now to the main feature of this extension of Part VII., still further proof is desirable in connection with these matters, and to this end some additional averages of values will be given in support thereof.

Referring to the satellite distances, it should particularly be noted that the value of the constant, K, is adjusted to suit existing distances as recorded in Chambers' treatise on astronomy. Should these values become altered, as they are not known with great accuracy, the constant would, of course, have to be recalculated. It may be objected, however, that in giving averages the writer has ruled out certain values which appear to be represented by the numbers 7, 9, 13, 21, 48. To meet this possible objection, the following averages are given, which include all values within the limits which seem reasonable, the figures being taken from previous parts of this series of papers.

		I.	II.
(47.48 + 48.42 + 48.33)/3	=	48.07	48.3
(19.76 + 22.01 + 16.95 + 25.00)/4	=	20.93	21.1
(14.77 + 13.84 + 12.14 + 14.16 + 12.37 + 11.54)/6	=	13.14	12.8
(9.00 + 9.46 + 9.29)/3	=	9.25	9.0
(6.46 + 7.65 + 6.72)/3	=	6.94	6.9
Averages		19.66	19.62

In Column II. are given the calculated values for the Balmer lines, α, β, γ, δ, ϵ, using the formula: $(\lambda - 3540)/62.5$. The Balmer line, ζ, $(\lambda = 3889.21)$ by this equation gives the value 5.58, which, as previously stated, is near to the values for Mimas and the near satellite of Jupiter.

Not knowing whether the values in Column II. should be taken as a standard rather than the pure whole numbers, 48, 21,

&c., the values of I. and II. may be averaged with the following result:—

(48.07 + 48.3)/2	=	48.18	48
(20.93 + 21.1)/2	=	21.01	21
(13.14 + 12.8)/2	=	12.97	13
(9.25 + 9.0)/2	=	9.12	9
(6.94 + 6.9)/2	=	6.92	7
Averages		19.64	19.60

Thus it will be seen that all these values range closely round the numbers, 48, 21, etc.

It should be noted that, curiously, the dividing constant in the case of the planets, which represent the largest-scale phenomena, perhaps, possible to consider, is 10,000,000; whereas, the dividing constant for the smaller-scale phenomena, that of the satellite distances, is 19,310.

A Correction.—On page 387, *Summary*, substitute: "In this paper it is shown that the satellites of Uranus, Jupiter, Saturn, and the Earth in respect of their radial distances, follow a planetary displacement rule represented by, &c."

PART VIII.—OTHER PHENOMENA.

These studies seem to indicate that radiation may take a closed form round the positively charged nucleus of the atom while the electron becomes the operator, as sketched above. If this idea is in general true, then it would seem to throw some light on such phenomena as—

1.—Fluorescence.*
2.—Phosphorescence.*
3.—After-glow in gases.
4.—Globular lightning.

* See Wood's "Physical Optics," 3rd Edition, for an account of these phenomena.

In these cases it may be assumed that some electrons are more or less discharged from the substance by the radiation absorbed, and then if the radiation of the proper wave-length falls on the substance, absorption may take place as "closed radiation," only to be emitted when the substance recovers internally or externally, the electrons displaced or completely removed (as the case may be), when the substance becomes wholly electrically neutral again.

Of particular interest, therefore, in this connection, is the phenomenon of ball lightning, known also as fire-balls, globular lightning, and thunder-bolts, though the last-named expression is used more by ignorant persons in reference to ordinary lightning discharges. Meteorites may be described as fire-balls, which confuses the meaning of this term, so that the first and third names are best.

Referring to this phenomenon, an interesting statement about thunderstorms and globular lightning appeared in *Nature*, Nov. 17, 1923, under the pen of Dr. G. C. Simson, where it is recorded that the chief characteristics of ball lightning, so far as known at present, are:

1. "The body or ball itself, which is able to retain its individuality as it moves through the air, appears to be composed of gas or matter in some novel luminous condition.
2. "The balls appear to exist independently of any large electrical intensity, for they have been observed within closed rooms, where large electrical fields are impossible; and also have been observed to pass in and out of parallel telegraph wires [they are known to come into the room from a chimney during a thunderstorm.]
3. "They appear to be associated directly or indirectly with large quantities of energy, for they have been observed to explode with violence, and have also been seen to fuse the overhead wire of an electrical tramway [this wire may be ⅜ of an inch in diameter]."

"No satisfactory explanation of ball lightning has been offered." Dr. A. Russell refers in this connection to a "brush discharge taking place in a column of air of higher conductivity than the neighbouring air." This is most suggestive, as will be seen from the next paragraph.

This phenomenon is of such rare occurrence that little opportunity has been afforded to study it; but it seems quite possible that the normal discharge of lightning might cause a body of free particles to become positively charged, owing to the photo-electric effect due to the ultra-violet light emitted by the discharge. If these particles are present in great numbers in a sort of self-contained cloud or whirl, they might then form nuclei round which the radiation of the concurrent, or a following, discharge could circulate, and thus form in a crude way a sort of huge atom. The stability of such a system would not persist indefinitely as the return of the electrons to their normal positions round the nuclei would restore equilibrium, but in the interval radiation would be emitted from such a system, according to the views developed in this study. This idea, at any

rate, suggests carrying out experiments with highly charged clouds of particles and electric discharges; but it is perhaps well *to caution the inexperienced experimenter*, as very dangerous combinations might be formed.

4′ ACETYLAMINO 1 PHENYL 5 METHYLBENZOTHIAZOLE.

By R. F. Hunter.

In view of the recent work on the bromination of the compounds of this type in glacial acetic acid solution, it was thought that the acetyl derivative of dehydrothiotoluidin should be capable of adding bromine according to the equation:

$$CH_3C_6H_3 <^{S}_{N}> C\ C_6H_4NH\ CO\ CH_3 + 2Br$$

$$= CH_3C_6H_5 <^{S}_{NBr}> CBr\ C_6H_4NH\ CO\ CH_3$$

to yield the usual type of dibromo addition product. It was therefore decided to prepare the acetyl compound according to the standard methods, and to study its bromination.

Experimental.

It was attempted to prepare the acetyl compound by the action of acetyl chloride on the pure base prepared by the method described by the author some time ago in the *J.S.C.I.*

0.2 gm. of base was placed in a test tube and excess of acetyl chloride added. A vigorous reaction took place, and hydrochloric acid was evolved, the product was filtered, washed with 15 per cent. HCl, NaOH, and much water; the residue was minute and useless for investigation, while the filtrate was of a golden colour. Either the acetyl compound was soluble, or the addition of water and HCl had caused hydrolysis, the base going into solution as the hydrochloride.

$$CH_3C_6H_3 <^{S}_{N}> C\ C_6H_4\ NHCOCH_3 -$$

$$CH_3\ COOH + C_{14}H_{12}N_2S.HCl$$

Another method was obviously necessary. 0.5 gm. of base was heated for two or three minutes in a bunsen flame with excess of acetic anhydride; immediate solution took place. The solution was then poured hot into a beaker of cold water. A pale grey precipitation took place. The contents of the beaker were allowed to stand a minute or two and then filtered. The solid was washed with water. A portion of the product was dissolved in glacial acetic acid in a beaker, and bromine was added drop by drop to the solution, which was kept well stirred during the addition. A red brown precipitate was formed on the addition of the first drop of bromine. Excess of bromine was run in, the solution allowed to stand for a short time, and then drowned with cold water. The product was a deep brown solid.

The Imperial College of Science and Technology.

September, 1923.

DAMAGE TO FACTORIES CAUSED BY THE EARTHQUAKE IN JAPAN.

Japan Artificial Fertiliser Co.

This company has many factories throughout the country, those located in the earthquake area being at Oji, Kamayabori, Komatsugawa, Kinoshitagawa, Koyasu, and Yokohama.

With regard to the extent of the damage at the Oji factory, one-tenth of the sulphuric acid works was destroyed, and one-quarter of the electrolysis plant. It is hoped to restore the former by the end of September, but it will not be possible to re-open the chemical and electrolysis sections before the end of October, while entire reconstruction of the factory will need six months. There is an ample stock of fertiliser.

The factory at Kamayabori was demolished by the earthquake and gutted by fire, but it is expected that 70 per cent. of the stocks of fertiliser can be used.

At the Komatsugawa Works, three of the retorts for making sulphuric acid collapsed and the roof fell in at two or three places, but work has already been restarted in part, and it is hoped that reconstruction will be completed in two or three months.

The amount of damage at the Kinoshitagawa Works was comparatively small, and it is expected that partial operations will be possible as soon as motive power becomes available, and that early in October the whole will be restored.

The works at Koyasu and Yokohama were burnt to the ground, but at the latter the phosphorite and another go down as well as the office and factory remain.

The total losses occasioned by the earthquake amount to Yen 4,650,000. At present there is little hope of the restoration of the factories demolished by fire, but there is no special anxiety with regard to supplies of raw materials, and in view of the ample stocks of the manufactured article it is probable that there will be no difficulty about meeting present demands.

Tokyo Sulphuric Acid Co.

This company manufactures concentrated and fuming sulphuric acid by synthetic processes. The damage sustained is almost nil, and given a supply of motive power, operations can be resumed immediately. About a month's supply of raw material is in stock.

Asahi Electric Industries.

Manufacturers of bleaching powder, caustic soda, solidified oils, hydrochloric acid, soap, etc. Damage is slight. A boiler room and one go-down partly collapsed, and a quantity of manufactured salt was washed away. Resumption of work is contemplated during September, and it is anticipated that there will be no reduction in output.

Japan Chemical Manufacturing Co.

The Kameido Works, which manufactured barium sulphate, salts of iodine, cosmetics, fertilisers, etc., suffered little damage other than the collapse of one factory, a brick chimney, and a water tank. Prospect of early resumption with usual output.

Iriya Chemical Manufacturing Co.

Factory at Sendagaya, Tokyo. Manufacturers of acids, brewing materials, ethyls, etc. No damage other than collapse of a store. There is every prospect of resumption of work as soon as readjustment of the factory is completed. There is a shortage of certain raw materials and an entire lack of stocks.

Meidensha Co.

The company's works at Ozakicho suffered little damage on the whole, but the walls of the works devoted to the manufacture of large electrical machinery are cracked, and the foundations of the heavy machines have slipped, making readjustment essential. Extensive repairs are not necessary in the case of the smaller machinery, and there is every prospect of an early re-opening. The output of small machines will suffer no change, but some time is needed for reconstruction in the factory for large machines. There is a stock of small machines, but materials are scarce, and a rise in price is feared.

Tokyo Electric Co.

The damage to the oil factory, which manufactures electric bulbs, is small. Part of the brickwork of the outer walls collapsed but there is little interference with the continuation of work, and the machinery has not suffered at all. Though operations can soon be resumed, the date of re-opening cannot be fixed upon, on account of the lack of gas necessary for fusing the glass. The crucibles for glass melting were entirely destroyed, but repairs were taken in hand immediately. An ample stock of raw material exists.

The same company's Kawasaki factory suffered severe damages. The laboratories and engineering shops collapsed, killing several employees, and stocks of materials and manufactured articles appear to have been destroyed. Other parts of the works, too, suffered a similar fate, and it is impossible to say when the factory will be reconstructed. The manufacture of the better class bulb which used to be carried on at this factory is to be transferred to the oil works.

Sonoji and Co.

The Ozaki Works of this company were hardly damaged, and resumption of operations will be possible as soon as motive power is available. The works manufactured industrial tools, gauges, and similar articles, for which there will be no demand until the industries in the devastated zones are restored, so that the factory is preparing to turn to the manufacture of materials urgently needed.

Imperial Alloy Refinery.

Repairs necessary to a portion of the works which collapsed will have no serious effect on the factory's activities, and it is proposed to resume work as soon as there is a demand. As regards raw materials, there is a shortage of ferro-silicon.

Mukojima (Tokyo) Plating Co.

Makers of zinc plates. Damage slight. All stocks requisitioned, but there is a certain amount of raw material (iron sheets). There is a shortage of ammonium chloride, but work can be resumed on receipt of supplies.

Meiji Rubber Manufacturing Co.

On the whole, the damage done at the Shinagawa (Tokyo) Works was small, but, in addition to the loss of some hydraulic

and other presses, two buildings were half demolished. The go-downs, etc., are safe. Output reduced by 20 per cent. It is not possible to indicate the date of restoration. There is a stock of raw materials for the present, but it is apprehended that there may be a shortage in the supply of some of these.

Sakura Rubber Co.

Buildings undamaged, but there is some damage to the iron tubes of the machinery. Restoration is likely to cost Yen 10,000, and to be completed by the middle of October, when work will be resumed. There is a month's stock in the go-downs, also a supply of raw rubber, but chemicals are deficient.

Fuji Rubber Manufacturing Co.

Manufacturers of cycle tyres, hose, etc. Chimneys, boilers and one go-down damaged to such an extent as to preclude their use. Restoration will take two months. There is a certain amount of stock.

Union Rubber Co.

Factory burnt, but there was no other damage. No stocks of either raw materials or manufactured goods. Re-opening indefinite.

Central Rubber Co.'s Honjo Works.

Damage to boilers and chimneys. Owing to complete lack of materials, like calcium carbonate, litharge, carbon black, sulphur, petrol, grease, machine oil, etc., it is impossible to resume for the present.

Japan Cycle Rubber Co.

Azamacho factory.—A portion collapsed, but a month's supply of manufactured goods and some telephone instruments and hose are in stock. No loss of life and no special damage to machinery, so that early reconstruction is expected.

Takasago Rubber Co.

Zeshigaya (Tokyo) factory.—Damage was restricted to the one go-down, and if supplies of raw material are obtainable it will be possible to turn out rubber hose, tyres, rubber-soled Japanese socks, and other articles of practical use.

Fujikura Co.

Osaki-cho, manufacturers of waterproof cloth, aeroplane dope. In addition to the destruction by fire of the laboratory, part of the works were damaged, but when motive power becomes available it will be possible to resume without a decrease in output.

Japan High-Class Paint Co.

Part of the drying room at the factory at Sasazuka collapsed, and some raw and manufactured materials were lost, but general damage was small. Two or three months are necessary for repairs, but work is not interfered with, and the middle of October should see a resumption of activty.

Kojima Hard Rubber Manufacturing Co.

Little damage. Probably re-opening in October. There is a shortage of gasolene, but there is a certain amount of stock.

Chiyoda Industrial Co.

Factories at Oku and Kameido.

At Oku, where celluloid is made, some buildings collapsed but the machinery has been transferred to those parts of the factory which remain intact, and resumption is probable in October.

The Kameido Works made celluloid toys, cycle parts, and various celluloid articles. The factory was practically demolished, and little of the fittings are fit for further use. Taere was a certain asount of raw material in the go-downs, but no stock of manufactured goods.

Japan Paint Co. (works at Shinagawa, Tokyo).

Damage is slight, and factory can be speeoily restores with no diminution in output.

Taisho Turpentine Co.

At Shinagawa, manufacturing turpentine and preservative chemicals. Laboratories demolished; no stocks of raw materials or manufactured goods. Resumption not decided.

Japan Printing Ink.

Factory at Takata, office and go-down burnt. A shed has been built, and by using three machines which were saved, there is a prospect of manufacturing printers' ink for newspapers. A stock of one month's supply of raw material is available.

Oriental Ink.

Chimneys at the Ushigome (Tokyo) factory collapsed, and a go-down at Kyobashi was burnt. Supplies of the manufactured article and of raw materials are available, and work is being continued.

Japan China Spinning Co.

At Kameido. The factory operating 50,000 spindles was destroyed, but that operating 30,000 fared better. Owing to the shifting of the foundations, however, extensive repairs are necessary, restoration being expected after two months. There are ample stocks.

Oriental Muslin, Kameido Factory.

Two of the workshops were destroyed and two are safe. No fire occurred, however, and with a few repairs most of the machinery can be used. The company has, in ad-

dition, three factories in Shidzuoka-Ken, having 70,000 spindles and 1,000 looms. It is hoped to transfer there the machinery wrecked in Tokyo, and to cope with the situation.

Tokyo Woollen Cloth Co.

Oimachi factory, near Tokyo, having a monthly output of all woollen textiles of about 80,000 yards. Of the four works, the brick buildings suffered some damage, but, except for several power-looms, the machinery was unharmed. With speedy repairs and a return of electric power, work can be resumed and foreign style cloths and other materials urgently needed can be turned out. It is anticipated that there will be no reduction in output. Raw materials and manufactured goods on hand were not damaged, and it has been possible to supply the demand from the city tramways and railways.

On the other hand, the company's factory at Oji, which manufactured chiefly foreign style serges (monthly output 120,000 yards) was practically wiped out, and there is said to be no prospect of restoration.

At the Senju factory there was no damage other than that to one carding machine.

Shirokane (Tokyo) Cotton Hosiery Factory.

Practically no damage. When motive power is available, and the works have been reinstated, it will be possible to return to pre-earthquake output.

Matsuoka Cotton Hosiery.

Factory at Meguro (suburb of Tokyo). Little damage, and prospect of return to normal output when power and supply of raw material are restored.

Japan Leather Co.

Factory at Senju (near Tokyo), manufacturing boot leather, saddlery, belts, trunks, knapsacks, was rather seriously damaged, but reconstruction is expected in two months. Two months' supply of raw material is available, and there is some stock.

Meiji Leather Manufacturing Co.

Kinoshitagawa factory (at Azuma), damage slight, and work can be resumed as soon as motive power is available. A plentiful supply of raw material and manufactured goods is available.

(To be continued.)

GENERAL NOTES.

Mr. F. Watson, O.B.E., H.M. Consul-General at Philadelphia, reports that he has received an enquiry for British-made dye powders, soluble in non-drying oil, in black, red, and blue, for use in the process of inking typewriter ribbons.

U.K. firms desirous of receiving further particulars regarding this enquiry should apply to the Department of Overseas Trade, 35, Old Queen Street, London, S.W.1, quoting reference 21437/F.W./C.C./(2).

THE ANNUAL EXHIBITION OF THE PHYSICAL SOCIETY OF LONDON AND THE OPTICAL SOCIETY.

This Exhibition, which is to be held on Wednesday and Thursday, January 2 and 3, 1924, at the Imperial College of Science and Technology, South Kensington, will be open in the afternoon (from 3 to 6 p.m.), and in the evening (from 7 to 10 p.m.).

PROCEEDINGS AND NOTICES OF SOCIETIES.

SOCIETY OF GLASS TECHNOLOGY.

The President, Prof. W. E. S. Turner, D.Sc., presided at the meeting of the Society of Glass Technology, held at University College on December 12. The following papers were presented:—

An Apparatus for Calibrating Burette Tubes, by Verney Stott, B.A., F.Inst.P.

The method of calibration used was that of transferring successive quantities of water from the blank burette tube to a standard pipette. A piece of thermometer tubing was attached to the top of the burette tube by means of two pieces of rubber tubing and an adapter. The thermometer tubing controlled the rate at which air entered the top of the burette tube, and therefore controlled the rate of outflow of water from the burette tube. The pointing marks were made by folding a piece of black paper round the burette tube, and fastening it with seccotine, so that the top edge of the strip coincided with the bottom of the water meniscus. Details of the apparatus and its use were described.

Some Factors Affecting Efficiency in the Glass Trade, by Eric Farmer, M.A. (Industrial Fatigue Research Board).

The special problem discussed was the relative efficiency of different methods of dividing the working day. The investigation was carried out mainly in the Yorkshire district, where a change from the two-shift to the three-shift system had recently been made. The plan adopted was to select bottles which had been made for a lengthy period by the same "chairs" under both methods of sub-dividing the working day. It was found that the hourly output of the eight-hour shifts was practically in all cases greater, in the hand-made process, than that of the ten-hour shift. The increase was more marked in the case of large bottles than in the case of small bottles. With semi-automatic processes the results were the same. Corroboration was not obtained of the general opinion held in the glass trade that output was uniformly affected by hot weather. The effect of bad temperature conditions was cumulative, and so tended to increase fatigue as the day went on. It was found that the morning shift was always the least efficient throughout the year, and this inefficiency was particularly marked during the heat of summer. There was little difference between the afternoon and the night shifts, though on the whole, the night shift was less efficient than the afternoon shift. The effect of rest pauses was well known, but all stoppages of work were not so beneficial. The effect of stoppages due to the coal strike and the influenza epidemic was to lower efficiency, owing to loss of motor dexterity on the part of the workers.

Specifications in the Glass Industry, with Special Reference to Soda-Lime Glasses for Glass Containers, by Prof. W. E. S. Turner, D.Sc.

The subject had received emphasis owing to recent occurrences involving the interests of both the general public and glass manufacturers and users. In some branches of the glass industry specifications had been employed, or at any rate, some approach to standards had been made, for example, optical glass must possess a specific refractive index and dispersion. In the very important soda-lime glasses for containers, little had as yet been attempted in the way of specifications. There were two or three kinds of tests or specifications which might be applied, namely, specifications as to (*a*) composition, (*b*) use, (*c*) tests. For glass containers there were two essentials: (i) durability, and (ii) a satisfactory state of annealing. Glass for common containers should contain not more than 18 per cent. of sodium oxide in the finished glass, and not less than 8 per cent. of lime or calcium oxide. The conditions for annealing varied with the composition of the glass, and could not be specified. There were, however, definite methods of testing glassware for strain, so that manufacturers and users might exercise control over their products or purchases. Specifications were then considered, for (*a*) Medicine and Drug Containers, (*b*) Beer and Spirit Bottles, (*c*) Jam Jars, (*d*) Potted Meat Jars. The points to which particular attention had been paid were not the only ones the purchaser must consider. He would obviously take into account also such matters as correct capacity, freedom from sharp edges and satisfactory colour or absence of colour

The next meeting will be held on Wednes day, January 16, 1924, in the College o Technology, Manchester.

PHYSICAL SOCIETY OF LONDON.

The Annual Exhibition of Apparatu arranged by the Physical Society of Londo and the Optical Society was held on Ja 2 and 3, at the Imperial College of Scien and Technology, South Kensington, S.W.

During the exhibition the following di courses were given:—

The Heaps and Grylls Rapid Cinen Machine (designed to take photographs rates varying from 500 to 5,000 times p second, by Mr. H. B. Grylls.

The Nature and Artificial Production Human Speech (Vowel Sounds), by S Richard Paget, Bart.

At the meeting held on December Alexander Russell, M.A., D.Sc., in t chair, the following papers were read:—

The Aerodynamic Resistance of Sphe shot upward to Measure the Wind, Lewis F. Richardson, F.Inst.P., F. Met.Soc.

The resistance of the air to accurate s spheres has been measured by two methods: (1) by observing the tilt from vertical at which the sphere must be

jected in order that a measured wind-distribution may bring it back to the gun; and (2) under circumstances similar to those just described by comparing the muzzle velocity with the time of flight of the sphere. Measurements of the resistance of various spheres by about twelve different authors are collected in a single diagram, and the remarkable divergences between them are discussed, in relation to turbulence of the air, rotation of the sphere, and deviations from sphericity.

The X-ray Analysis of Zinc-Copper Alloys, by E. A. OWEN, M.A., D.Sc., and G. D. PRESTON, M.A.

Alloys containing up to 38 per cent. zinc constituting the α brasses are found to possess a face centred cubic lattice, the parameter increasing from 3.608 A for pure copper to 3.696 A for an alloy containing 38 per cent. zinc. Solution takes place by the substitution of zinc atoms for copper atoms.

The X-ray analysis of a brass containing 48.5 per cent. zinc by weight showed that the β brasses possess a centred cubic structure, the side of the unit cube being 2.946 A.

Specimens quenched from 550° C. and annealed below 470° C. gave identical spectra and showed no sign of the presence of the phase. The evolution of heat observed at 470° C. is not accompanied by a change of crystal structure, and is similar to the α-β transformation in iron. It is not accompanied by a breaking up of the β constituent into a mixture of α and γ.

Specimens containing 43.7 per cent. zinc by weight were examined. The first annealed at 750° C. and quenched showed the reflections due to β brass only. The second annealed at 500° C. and quenched, and the third annealed at 400° C. consisted of a mixture of the α and β phases. The results of X-ray analysis are in agreement with the constitutional diagram of Shepherd.

The γ phase is found to crystallise on a rhombohedral hexagonal structure of side 4.136 A and axial ratio 0.6495.

The ϵ phase gave a spectrum characteristic of a close-packed hexagonal lattice of side 2.718 A and axial ratio 1.585.

The zinc-copper system crystallises on a rhombohedral hexagonal lattice from copper to γ brass, and on a close-packed hexagonal system from ϵ (or possibly δ) brass to zinc. The observed parameter of the lattice of ϵ brass suggests that the copper atom causes the zinc atom to rotate about an axis perpendicular to a 1120 plane, until the zinc atoms in successive 0001 planes are separated by a distance equal to the side of the lattice of pure zinc. Fusion would then take place at about the same temperature in both cases.

The very low value of the density previously ascribed to an alloy containing 10 per cent. copper is not confirmed. The value found for the density of this alloy is 7.35 grms./cc. The observed density of the alloys examined is in good agreement with the value computed from X-ray data.

The hardness of the brasses attains a maximum in the region of γ brass, where the atomic volume curve shows the greatest departure from the straight line joining the atomic volumes of copper and zinc. The hardness of the α phase is ascribed to local distortion and that of the β phase to the difference in type of lattice. The relatively very great hardness of γ brass is due to small atomic volume and loss of symmetry.

The fact that the atomic volume curve consists of two straight lines suggests the existence of an allotrope of zinc with an atomic volume of 13.92 A^3. Consideration of the value of the parameter of the lattice of the β phase suggests that this phase is due to an allotropic modification of copper, with an atomic volume of 12.79 A^3.

DISCUSSION.

Dr. H. Weiss said that some of the results obtained by previous workers in the same field were palpably absurd. In some cases the diagrams obtained by X-ray analysis have borne no relation to those obtained by thermal and microscopical analysis; for instance, they have shown only one kind of lattice in regions where the previous methods clearly show two kinds of crystals. It was to be expected that X-ray methods in metallurgy would add to previously existing knowledge, but that they should contradict it does not inspire confidence in the school of workers who have hitherto pursued them. In view of these contradictions the author's work is the first of its kind calculated to inspire confidence in the minds of metallurgists. As regards the transformation of β brass into β', the conclusions reached by the authors can hardly be regarded as final, for it is impossible to be certain that the structure of the β phase, which is only stable above 470° C., is retained by the act of quenching. Conclusive results on this head can only be obtained by direct measurements at the

higher temperatures. It is likely that X-ray analysis will throw much light on the causes which give rise to the series of solid solutions, α, β, γ, δ, ε, η, but probably no useful theory can be framed until a large number of experimental determinations have been made for various other series. In Sir Wm. Bragg's laboratory the speaker had begun a study of the same subject by a photographic method. In the preliminary tests two kinds of samples were used: Those with very small crystals, which give well-defined but somewhat diffuse lines, were valuable in giving a general idea of the spectrum, while those with larger crystals, which give fine and clearly separated lines, were preferable for obtaining exact measurements. Samples were also submitted to an assistant in the laboratory who was skilful in the use of the ionisation chamber, but for the 111 plane of copper he was only able to obtain a deflection in his electroscope of eight divisions in 1/10 of a second, as compared with a deflection of 6 divisions for the troughs of the intensity curves in the same neighbourhood. The conditions seemed therefore very unfavourable for determning the peaks of these curves. Could the authors give some particulars as to their technique in this connection?

Mr. T. Smith referred to the comparison made between the volume elasticity of the alloys as measured in the ordinary way, and the forces acting upon atoms during strain. It did not seem safe to argue directly from one of these quantities to the other.

Dr. E. A. Owen replied. With regard to the results obtained with β brass, the investigation undoubtedly proved the absence of the α phase in a copper-zinc alloy containing 48 atomic per cent. zinc, annealed as described in the paper and quenched from 400° C. This would not be the case if the evolution of heat associated with the temperature 470° C. were accompanied by the splitting up of the β phase into the two constituents α and γ. He agreed that it would be desirable to investigate the structure of alloys at high temperatures, and they (the authors) hoped to be in a position to make such measurements in the near future.

In regard to the intensity of the peaks in the spectral curves, these varied according to the specimens examined. The intensities of reflections from planes rich in atoms were easily measurable. Small deflections could also be detected and measured with certainty after a little practice. For this work the speaker emphasised the necessity of maintaining a steady condition of discharge of the X-ray bulb. The reflections obtained with metals in the form of plates as used in the investigation were not as a rule as intense as those obtained with single crystals. It was pointed out that this was not a serious drawback, in view of the fact that the sensitive region of the scale of the tilted electroscope is limited. The definition of the peaks in the spectral curves is such that in general the maxima can be fixed to a few minutes of arc.

As regards Mr. T. Smith's criticism, the authors had thrown out some tentative suggestions, chiefly as indications of the lines of inquiry to be followed. The assumptions made were admittedly hypothetical, but on these assumptions the numerical results obtained from considerations of volume elasticity fitted in well with the results of the X-ray analysis.

Investigations of Piezo-Electric Effects with Dielectrics, by K. R. Brain, B.Sc.

Experiments on the piezo-electrification of dielectrics were described. The dielectrics examined were ebonite, glass, hornoid, sealing wax, rubber, celluloid, and hard paraffin. The relation of quantity to load was determined; with sensitive specimens the magnitude of the charge is of the same order as that found by Curie with crystals.

Fatigue and hysteresis effects in these dielectrics were established. Experiments on cubes showed a dissymmetry in results, suggesting an irregularity of structure.

The general similarity of the behaviour of these dielectrics to that of crystals leads to the assumption that they possess a quasi-crystalline character, and the effects are explained on this assumption, which has been verified by X-ray photographs.

THE INSTITUTION OF ELECTRICAL ENGINEERS.

An Ordinary Meeting was held on Jan. 3, when a lecture on *Railway Electrification in Foreign Countries* was given by Dr. S. P. Smith.

Some Experiments on the Screening of Radio Receiving Apparatus, by R. H. Barfield, M.Sc.

The chief object on the investigation was to obtain quantitative information on the effect of screens, of which the dimensions

are small compared with the wave-length of the waves they are intended to screen. Some preliminary experiments were described, in the first of which the screening effect of a totally closed iron tank was investigated by an operator inside it with a frame coil receiver; and in the second an investigation was made on the effect of screening a square frame receiving coil by totally enclosing each of its four sides in a metallic envelope. A description was given of the method employed in subsequent experiments of measuring the effect of screens based upon the employment of two receiving coils connected in opposition. This was followed by an account of measurements made by this method on some specially constructed screens of straight wires, open and closed loops, and wire-netting; etc. These measurements demonstrate the important part played by closed circuits in screening the magnetic field of radio waves, and show that an effective screen may be constructed of wire-netting. In this connection a description was given of the screening of the interior of a hut with this material to protect direction-finding apparatus within it from "direct pick-up."

Further experiments, in which the effect of screens on the electric field of the waves is measured, were described. Three types of screen investigated were shown to reduce substantially the electric field without affecting the magnetic field, while, later in the paper, it was shown that a fourth type will screen the magnetic field but not the electric field. A cage of the former type was described which is now in practical use as a means of eliminating "antenna" effect from a single-coil direction-finder contained within it.

Explanation of the various effects was given, and conclusions were drawn as to the general principles of screening and as to the essential points to be attended to in the design of efficient screens for various purposes.

NOTICES OF BOOKS.

Van Nostrand's Chemical Annual, 1922. Fifth issue, thoroughly revised and enlarged. Edited by J. C. OLSEN, A.M., PH.D., assisted by T. R. LECOMPTE, B.A., M.S. Pp. 900. London: Constable & Co. Price 21s.

Van Nostrand's Chemical Annual has been a valuable laboratory reference guide since it first appeared in 1909.

The present issue has been prepared under the general editorship of Dr. Olsen, who has had the co-operation of a number of American chemists in bringing the work up-to-date.

All the usual chemical, physical and mathematical tables of constants are given very fully, and there are a few sheets of blank square paper at the end. There is a frontispiece of Prof. T. W. Richards.

Dangerous Goods, by DR. JULES AEBY. Pp. XI. + 319. 2nd Edition, 1922. Messrs. Crosby, Lockwood & Son, 7, Stationers' Hall Court, E.C.4. 30s. net.

The author of this volume, written in three languages, French, English and German, is consulting chemist to the *Red Star Line* at Antwerp.

His book is intended primarily as a reference volume for shipping and transport agencies, and those who have to deal with the transit of such substances that call for special care. The major portion of the book consists of an alphabetical list of dangerous chemicals and preparations, with their characteristic properties, *i.e.*, whether solid, liquid or gas, inflammable, explosive, corrosive, poisonous, or obnoxious.

In this way, 442 bodies which might give rise to difficulties or cause accidents in transport are listed in the three languages.

For some reason the author has seen fit to quote temperatures on the Fahrenheit scale in the English section.

It is pointed out that the information given must in many cases be supplemented by a certain amount of *interpretation*, *e.g.*, the manner in which the goods are packed, the nature of the containers, and the mode of stowing are factors to be borne in mind.

There is a paucity of literature dealing with the transport of dangerous merchandise, and therefore this volume by Dr. Aeby is specially welcome.

Chimie des Colloides et Applications Industrielles, par LOUIS MEUNIER. Pp. 336. 1924. Paris: Librarie J. B. Baillière et Fils. Fcs. 30.

The first part of this work is devoted to an academic study of colloids, or, as the author urges, "the colloidal state" of matter.

Selmi, in 1845, first began to study the properties of colloidal solutions, but did not accomplish much, and the real foundation of scientific knowledge in this branch of

science was laid by Graham's researches in the sixties.

Graham's original distinction between colloids and crystalloids has needed modification, and Prof. Meunier instances the cases of such colloidal bodies as albumen, which can be now prepared in the crystalline state. On the other hand, sulphur, and even salt (NaCl) may be obtained in the colloidal condition.

The physical criteria for substances in the colloidal state are given, together with an account of the various disperse systems and the distinction between suspensoids and emulsoids. After discussing the general properties of these different systems, the author describes the modes of preparation of numerous colloidal bodies, under three general headings: — Precipitation methods, dissolution methods or peptisation, and processes of electric dispersion.

Attention is also paid to the phenomena and applications of adsorption.

The second part of the book deals with the industrial applications and uses of colloids. Much space is given to the preparation of artificial silks and other cellulose preparations, and to the chemistry of dyeing of both animal and vegetable fibres.

The properties and uses of such substances as albumen, gelatin, the starches, tannins and soaps are considered in some detail. There are also brief accounts of the nature and properties of other products met with in the colloidal state, including rubber, clays and diastases.

The Department of Scientific and Industrial Research has issued (through H.M. Stationery Office) the *Fifth Report on Colloid Chemistry and its General and Scientifi Applications.* Price 2s. 6d. net. This final report includes six papers contributed by recognised authorities, and there are indexes to the five reports.

The papers are entitled:

1. *The Maesurement of Surface Tension*, by Allan Ferguson, M.A., D.Sc.
2. *Report on Collagen and Gelatine*, by Prof. H. R. Proctor and J. A. Wilson.
3. *Colloid Phenomena in Bacteriology*, by E. K. Rideal, M.A., D.Sc., F.I.C.
4. *Industrial Applications of Wetting-Power*, by W. H. Nuttall, F.I.C.
5. *Colloids in Relation to the Manufacture of Inks*, by C. A. Mitchell, M.A., F.I.C.
6. *The Manufacture of Artificial Silk in Relation to Colloid Chemistry*, by Edward Wheel

BULLETINS ISSUED BY THE DEPARTMENT OF THE INTERIOR, UNITED STATES GEOLOGICAL SURVEY.

Arsenic in 1922, by V. C. Heikes and G. F. Loughlin. Pp. IV. + 76.

Strontium in 1922, by George W. Stose. Pp. 59-61.

Quicksilver in 1922, by F. L. Ransome. With a Supplementary Bibliography, by Isabel P. Evans. Pp. 113-124.

Magnesium and its Compounds in 1922, by J. M. Hill and G. F. Loughlin. Pp. 41 to 57.

Fuller's Earth in 1922, by Jefferson Middleton. Pp. 69 to 71.

Surface Water Supply of the United States, 1919-1920, Part VI., Missouri River Basin, by Nathan C. Grover. Pp. 411.

Surface Water Supply of Hawaii, July 1, 1918 to June 30, 1919, by Nathan C. Grover. Pp. IV. + 123.

The Twenty Mile Park District of the Yampa Coal Field, Routt County, Colorado, by Marius R. Campbell. Pp. IV. + 82.

New Patents.

This list is specially compiled for *The Chemical News* by Messrs. Rayner & Co., Registered Patent Agents, of 5, Chancery Lane, London, from whom all information relating to Patents, Trade Marks, and Designs can be obtained gratuitously.

Latest Patent Applications.

31168—*Ammonia Casale Soc. Anon.*—*Catalysts for* synthesis of ammonia. Dec. 11.

31116—Hurt Engineering Corporation.—Manufacture of sulphuric acid. Dec. 11.

31362—Vains, A. R. De.—Chlorination of raw cellulose. Dec. 13.

Specifications Published this Week.

192032—*Guggenheim, Bros.*—*Manufacture of* sodium nitrate.

207569—Fairlie, A. M.—Acid plant equipment.

207678—Aische, M. I.—Manufacture and production of soluble sulphonated oils of animal origin.

195598—L'Air Liquide Soc. Anon. Pour l'Etude et *l'Exploitation des Procedes G.° Clande.*—Preliminary treatment or purification of illuminating or coal gas or coke-oven gases intended for the recovery of hydrogen by partial liquefaction.

Abstract Published this Week.

206083—p-Phenetol-carbamide; phenacetin.—Sonn. A., of 5, Heumarkt, Konigsberg, Prussia, Germany.

p-Phenetol-carbamide is produced by adding a concentrated aqueous solution of potassium cyanate *to a solution of p*-phenetidine in an excess of diluted acetic acid. The reaction may be combined with the production of phenacetin, in which *dilute acetic acid forms a* by-product.

Messrs. Rayner & Co. will obtain printed copies of the published specifications and abstract only, and forward on post free for the price of 1s. 6d.

THE CHEMICAL NEWS,

VOL. CXXVIII. No. 3326.

ARE THE NATURAL GROUPINGS OF THE ELEMENTS AND THE SPECTRAL LINES OF HYDROGEN RELATED?

PART IX.

BY F. H. LORING.

In continuation of this study from *The Chemical News*, 1924, CXXVIII., p. 5, attention is here drawn to the spectral series other than that of the Balmer one in connection with the matters under investigation.

If, now, the Balmer and Lyman series be arranged as here shown, certain relationships are clearly indicated:—

λ in A units = $(3646.13/4)2^2/(2^2-1^2)$.
λ in A units = $(3646.13/4)3^2/(3^2-1^2)$.
&c. &c. &c.

It would appear that no proper satellite could be nearer to its planet than *about* 6,758 miles.

In some respects the rings of Saturn resemble banded or fluted spectra; an observation now justified, since practically the whole planetary phenomena is analogously related to optical spectra, or to the phenomena of hydrogen as so represented. The small bodies of the ring-formation close to the planet Saturn need not, however, be treated as satellites proper.

Dealing now with the other end of the hydrogen spectrum, where the Paschen and and Brackett series occur, it might be antipated that these spectra would give some

Balmer Lines.	Balmer Lines/4.*	Lyman Lines.	Group No./4.
6563.04			
λ vac. 6564.60			
4861.49			
λ vac. 4862.68	1215.67	1215.7 Millikan	5.250
4340.66			
λ vac. 4341.68			
4101.90			
λ vac. 4102.89	1025.72	1026.0 Lyman	2.250
3970.25			
λ vac. 3971.19			
3889.21			
λ vac. 3890.15	972.53	972.7 Lyman	1.395

* A known procedure.

Considering now the satellites of Mars, the constant, 19,310, should be divided by 4, which gives 4,827.5 (see Part VII.).

Making use of the reduced group numbers, *i.e.*, these divided by 4, as partly given in the fourth column above, these, when used as multipliers, should give the corresponding radial distances for the *near* satellites in miles, as follows:—

12.00 × 4,827.5 = 57,930
5.25 × 4,827.5 = 25,344
2.25 × 4,827.5 = 15,689 Deimos = 15,000
2.25 × 4,827.5 = 10,862
1.75 × 4,827.5 = 8,448
1.40 × 4,827.5 = 6,758 Phobos = 6,000

It is to be noted that the Lyman series may be closely calculated from the following equation (see Balmer equation, page 257).—

values in agreement with the extreme satellite distances, as yet so far out of the range of calculation as to yield no useful figures. Moreover, it might be expected that, instead of dividing by 4, the Balmer values should be multiplied by 4—in one case at least.

There are two Brackett lines of wavelengths *about* 26,300, and *about* 40,500. *The former can be obtained by multiplying* the Balmer α line, 6564, by 4, which gives 26,256. This value is within the present experimental error in respect of this measured wave-length.

In the case of the higher value, 40,500, by extrapolation the corresponding wavelength on the Balmer scale should be 40,500/4 = 10,125. Then, using the formula, $(\lambda-3540)/62.5$, gives 105. Multi-

plying this figure by 4 gives 420, which is very roughly the value for Phœbe (p. 388). Similarly, in the case of 26,300, 26,300 ÷ 4 = 6575. (6575—3540)/62.5 = 48.5. 48.5 × 4 = 194; but this value does not correspond to any satellite distance recorded in these papers. It should be noted that none of the Brackett values are known with sufficient accuracy properly to test the relationships indicated in this paragraph. For example, "40,500" has a *plus* or *minus* experimental error of about 300.

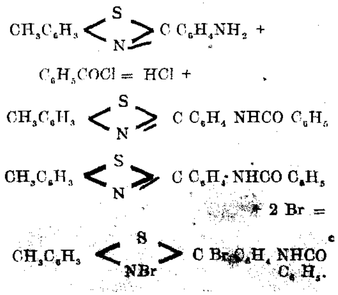
Historical Note.

Johann Elert Bode (1747-1826), a German astronomer born at Hamburg, "gave currency to the empirical rule known as Bode's Law, which was actually announced by Johann Daniel Titius." This discovery is sometimes referred to as the Titius-Bode Law.

THE BENZOYLATION OF DEHYDROTHIOPARATOLUIDINE AND THE BROMINATION OF THE PRODUCT IN GLACIAL ACETIC ACID.

By R. F. Hunter, F.C.S.

Dehydrothiotoluidin, since it is a primary amine, should be capable of benzoylation in the usual way by means of benzoyl chloride, and further, this benzoyl compound should be capable of yielding a dibromo product in glacial acetic acid if the explanation as to the formation of these dibromo products which has already been put forward by the author is correct; that is to say, the scheme of the reactions should be of the form outlined:



It was therefore decided to benzoylate the pure base prepared by the method given by the author, to which reference has already been made (*loc. cit.*) 0.5 gm. of the dehydrothiotoluidin was placed in a test-tube, and an excess of benzoyl chloride added, and the tube gently warmed for a few minutes. A vigorous reaction took place with the evolution of hydrochloric acid. The tube was then cooled in water. The product of the reaction was then filtered off and washed several times with 15 per cent. HCl to remove any unchanged base. The residue was then washed in succession with NaOH, water, and dilute alcohol. The yield at this stage was fair, and the product remained as a yellow brown solid, which was found to be soluble in alcohol. The whole was, therefore, treated with alcohol, refluxed for a short time, filtered, the bulk of the alcohol distilled off, and the concentrated solution allowed to cool. Yellow brown crystals were formed on cooling, which were filtered and dried. The purified product was then dissolved in glacial acetic acid in a small beaker, and bromine added drop by drop with stirring to the solution. The first drop of bromine produced the usual form of precipitate of a brown orange colour. Further bromine produced further precipitate. The beaker and its contents were allowed to stand for a minute or two and then drowned in cold water. The product was an orange brown solid.

The Imperial College of Science and Technology, S.W.7.
September, 1923.

ATMOSPHERIC CORROSION OF METALS.

A considerable advance in our knowledge of the phenomena of tarnishing, which forms the first apparent stage in the corrosion of metals, has been achieved by Mr. W. H. J. Vernon. His recent paper read before the Faraday Society in London is a report on work carried out for the British Non-Ferrous Metals Research Association. The object of the investigation has been to study the relative behaviour of different metals when exposed to atmospheric influences, both indoors and outside.

Very briefly, the results so far achieved may be indicated in the following, but since the paper contains a mass of detailed observations, the original must be consulted by those desirous of following the full sig-

nificance of the research.

In the first place, the enormously greater attack of iron than of other metals is brought out, and although this side of the subject is only incidentally touched upon, its practical value to all who have to select materials for domestic or constructional purposes is obvious.

The detailed study has brought out for the first time the marked difference in the mechanism of corrosion with different metals. This discovery promises to prove of the greatest importance, both from a practical point of view as well as in leading to a further elucidation of the whole question of corrosion.

Three different types of tarnishing have been distinguished. In the first type, represented by copper, the tarnish film actually protects the metal from further attack, the progress of tarnishing becoming slower and slower as exposure proceeds. This is accounted for by the supposed continuous layer which the tarnish film forms, and the consequent difficulty the corroding constituents of the air find in reading the underlying metal.

In a second type the tarnish is neutral, and the attack proceeds steadily, for instance, zinc, in a dry atmosphere, in this case it is probable that the film is previous to the air. Finally the corrosion, whilst strating off fairly slowly, may become accelerated, and this forms the third type, exemplified by iron; it is suggested that here the corrosion product—rust—assists in the attack.

Some metals, such as zinc, brass, etc., may follow more than one type of progress, according to the atmospheric conditions, or even to the thickness of the tarnish film. For instance, with brass the attack first proceeds uniformly, but later the film exhibits a protective influence, and the attack slows off.

Then the author has investigated other apparently quite distinct types of film which form upon cerain metals when exposed to the air. Nickel and some of its alloys at first seem not to tarnish at all, but rather to condense or produce on the surface a fog or cloudiness, which can be readily removed by simple washing with alcohol, restoring the bright metallic surface underneath.

The discussion on the paper helped to emphasise the importance of a detailed laboratory study of the tarnish films themselves. Reflectivity measurements have already been applied by Mr. Vernon to determine quantitatively the progress of tarnishing. The future seems to demand a greater knowledge of the constitution and life-history both of the friendly and of the enemy films, and it is to be hoped that the British Non-Ferrous Metals Research Association will be able to mobilise the interest and support of the large body of manufacturers and users, so that this can be done, and that exposure tests under widely different climatic conditions can also be continued.

THE DYEING OF CELLULOSE-ACETATE SILK.

A meeting of the Manchester Section of the Society of Dyers and Colourists was held on December 21, William Marshall, Esq., J.P., F.I.C., F.C.S., being in the chair.

A paper entitled *The Dyeing of Cellulose-Acetate Silk* was read by Mr. L. G. Lawrie, A.I.C., who said that the introduction of a new artificial silk, possessing quite different dyeing properties to the other commercial fibres, is an event of sufficiently rare occurrence to excite considerable interest amongst those connected with dyeing and textiles. This artificial silk, cellulose-acetate silk, has therefore been the subject of a very considerable amount of research work, and whilst only two or three years ago it was with the greatest difficulty that a limied range of colours could be dyed on this material, excluding the dyeing of the saponified silk, at the present time there are quite a number of distinct methods of dyeing it, and the introduction of this artificial silk has already given rise both to new series of dyestuffs and to new dyeing methods.

This fibre differs in many important respects to the other artificial silks in its behaviour towards the various chemical agents used in the dyehouse. With caustic alkalies the silk is saponified, the acetyl groups of the cellulose-acetate molecule being replaced by hydroxyl groups giving a modified form of cellulose. The silk so treated is then capable of being dyed with direct, vat or sulphur colours in a similar manner to cotton or viscose. This saponification results, however, in a loss in weight of the silk, which is a considerable disad-

vantage from a practical point of view. Cellulose-acetate silk is very sensitive to hot water at a temperature of 90° C. or higher, when the silk shrinks and loses its lustre, so that it is always dyed at a low temperature of about 75° C.

This fibre is also very resistant to wetting out, and it absorbs water more slowly and to a less extent than either cotton or viscose. Another characteristic property of the silk is its solubility in organic solvents, such as acetone, pyridine, etc., and it swells up and forms a jelly with chloroform. The other main chemical reactions of this fibre are very similar to those of cellulose.

The first attempts at dyeing this silk were by the utilisation of those dyestuffs already on the market. It was then seen that the silk had a noticeable affinity for dyestuffs of a basic character, and little or no affinity for dyestuffs containing sulphonic acid groups. Dyeing with basis colours, or with the few acid and chrome colours having an affinity, soon gave place to dyeing with the bases themselves, first as their hydrochlorides, and latterly as the free bases by precipitation with alkali for which the acetate silk has a very marked affinity. By diazotising and developing these bases on the fibre a much increased range of shades was available. A considerable improvement was made when Professor Green discovered that by the conversion of these bases to their omega sulphonic acids, as with the ionamines, they were rendered soluble, but capable of easy dissociation in the dyebath with the regeneration of the base from which they were prepared, which was instantly taken up by the fibre.

A considerable step forward was made when it was found by the British Celanese Company that certain colours, simple amidoazo bodies, etc., could be "dissolved" by heating with such substances as turkey red oil, sulphonated ricinoleic acid, and many other colloidal bodies, and the resulting mixture poured into water gave what appeared to be a true colour solution, but was in reality a highly dispersed colloidal state. Such dispersed colours were found to dye the silk well, and this method, which can be called, for want of a better name, "Dispersion Dyeing," is capable of a very extended use. Other colours can be used by this method, such as Spirit Yellow I, Quinoline Yellow Base, Indophenol, etc., as well as such bases as dianisidine, tolidine, benzidine, etc., which are taken up readily and can be diazotised and developed on the fibre. The range of these dispersol colours has been recently extended by the very important addition of red, violet, and blue amidoanthraquinone dyestuffs by the British Dyestuffs Corporation, thus giving an almost complete range of colours possessing excellent fastness to light. This series of compounds has at the same time been used in the production of similar ionamine dyestuffs.

Attacking the dyeing problem from a different point of view, the British Dyestuffs Corporation patented the use of amidoazo bodies, etc., rendered soluble by the introduction of carboxylic acid groups, which compounds also have a considerable affinity for cellulose-acetate silk. Still another method of overcoming the lack of affinity of those dyestuffs containing sulphonic acid groups was by altering the position of the sulphonic acid group in the dyestuff molecule, when, in certain positions, considerably increased affinity was obtained.

The dyeing of union materials of cotton and cellulose-acetate can be easily accomplished, as the majority of direct cotton colours have no affinity for the acetate silk, and most of the cellulose-acetate colours have no affinity for cotton. By a judicious selection of suitable colours, either solid shades or contrast effects can be obtained by a one-bath process. The dyeing of wool and cellulose-acetate mixtures is a more difficult process, as practically all the dyestuffs capable of dyeing acetate silk also dye the wool and usually dye it a different shade. There are, however, certain colours which dye both the wool and the silk the same shade.

Cellulose-acetate can be readily printed with direct, vat and sulphur colours by the addition of caustic soda to the printing paste, which produces a slight but sufficient superficial saponification of the silk which allows of the colours being fixed on the fibre.

At the conclusion of the lecture a number of photomicrographic lantern slides were shown, most of them being sections of the dyed material, showing the penetration, etc., of the dyestuff.

The Report of Sir S. W. Royse & Co., Ltd., on Chemicals, issued on December 31, states that though business generally is better now than it was 12 months ago, some disappointment may be expressed that its

progress has not been greater and that prospects of a solid improvement at an early date still remain obscure. It has continued spasmodic and chiefly for near delivery, though recently rather more confidence has been apparent. The position has been dominated by the French occupation of the Ruhr district, which took place in January, and which has had a bad effect on the course of foreign exchanges and interfered with trade. It is hoped that the coming international discussions will assist towards a satisfactory solution of the European situation, without which no permanent improvement in business can be expected. The settlement in the Near East in August was a step in the right direction.

The export trade has continued under the influence of the adverse rates of exchange, which in some cases, notably Germany, France, and Belgium, are much worse than they were at the end of 1922. The import trade has been again subject to considerable delays in shipments from the Continent.

DAMAGE TO FACTORIES CAUSED BY THE EARTHQUAKE IN JAPAN.

(*Continued from Page* 11.)

Tanaka Leather Manufacturing Co.

At the Hiratsuka (20 miles from Yokohama) factory, where boot and military leather is made, a brick go-down was half destroyed, and a boiler was damaged, but repairs should be completed in one month. Motive power is not deranged.

The same company's Asakasa (Tokyo) factory was utterly destroyed, and there is no hope of reconstruction. The company has a certain amount of both raw material and manufactured goods.

Kaikosha.

At Terashima, makers of imitation leather; damage is slight, but there is no stock of raw material on hand, and resumption is difficult.

Fuji Leather Cloth Co.

At Terashima, makers of imitation leather; serious damage; resumption expected at end of the year.

Marusa Celluloid Co.

At Terashima, makers of celluloid stationery articles, toys, and miscellaneous articles; damage slight. One month's supply of raw materials on hand. Reopening expected during September. An ample stock of manufactured articles exists.

Ichiyo Celluloid Co.

At Terashima the factory suffered considerable damage, but there is no difficulty about reopening, and supplies of raw material are easily obtainable. As export of manufactured articles is difficult, the factory will probably remain closed for the rest of the year. There are no stocks.

Maruyama Match Factory.

At Shirokane (Tokyo), no damage was sustained other than that to part of the pans, and work can be resumed immediately raw materials are received. There were four factories in Tokyo, three of which were gutted by fire, leaving only the one at Shirokane. No stocks exist.

Japan Lead Pencil Co.

Factory at Sasazuka. Except for the collapse of the fireproof wall of a go-down, damage was slight, and it will be possible to resume as soon as power is available. There are no stocks, and anxiety is felt on account of the scarcity of some materials.

Red Line Clinical Thermometer.

Factory at Hatagaya. Practically no damage, and work will probably be resumed immediately.

Tokyo Electric Hatagayā Works.

Manufacturing electric lamps. Practically no damage, and work will probably be resumed immediately.

Takachiho Works.

At Hatagaya, manufacturing microscopes, microscopic slides, spectroscopes, etc. Practically no damage, and the factory's activities can readily be resumed.

Aashiglass Co.'s Tsurumi Factory.

The greater part of the factory suffered severe damage, and will have to be entirely rebuilt. Reconstruction will take from six months to a year. The capacity of the factory is 36,000 cases a month, but as the capacity of the Tobata factory is a similar quantity, there is no difficulty in supplying present demands if the amount of stocks is taken into account.

Tachibana Glass Company.

Manufacturers of table ware, glass for electric lamps, etc. Damage is slight and early resumption probable. There is, however, a shortage of soda ash.

Shinagawa White Tile Co.

The only damage at the Shinagawa (Tokyo) Works was the collapse of a chimney and two stores. No decrease of output is anticipated. There are no stocks on hand.

Asano Cement.

The Fukagawa Works were utterly destroyed by fire. One-third of the Kawasaki

Works was damaged. Reconstruction of the former will take one year, and of the latter three months. The capacity of the Fukagawa Works was 60,000 barrels per month, and of the Kawasaki Works 150,000 barrels, but in a few months a capacity of 100,000 barrels should be developed by new equipment at the Tsurumi Works. The stocks at both factories cannot be used.

The company has, besides, factories at Moji with a capacity of 220,000 barrels; in Kokkaido, 120,000 barrels; and in Formosa 60,000 barrels. The Kokkaido factory is to be enlarged in the near future so as to have a capacity of 220,000 barrels. It is anticipated that the total capacity will then be 710,000 barrels, and there is no fear of shortage.

Ishikawa Pottery, Shinagawa.

Manufacturers of porcelain for chemical purposes. The works for machine-made goods of 70 tsubo was destroyed, and the firing works had a chimney damaged. No prospect of immediate resumption. There are some stocks on hand.

Torii Pottery, Terashima.

Manufacturers of tiles and bricks for building and decorating. Severe damage sustained, and prospects of restoration are remote. A certain amount of raw material is available, but there are practically no stocks.

Okada Bottle Manufacturing Co.

This company's factory at Azuma-cho makes wine bottles. Damage is slight, and reopening will be possible with the return of motive power.

Tokyo Brick Co.

At Ejimura (Tokyo suburb). One round kiln was destroyed, and chimneys collapsed. Date of resumption is unknown, but if it is decided to reopen, two or three months will be needed for restoration. As the chimneys can be repaired in about a month a portion of the work can be restarted by means of the undamaged kilns.

Chiyoda Brick Co.

At Oji, factory for manufacture of red bricks. Twelve buildings were half demolished, and two kilns totally destroyed. A part of the manufactured and semi-manufactured goods were also damaged, but there was considerable stock. It has not yet been decided whether to carry on, but if such a decision is made, reconstruction will take two months.

Saito Brick Co.

At the Ekitamura factory three chimneys were totally destroyed, and a factory area of 250 tsubo was demolished, the remainder being half destroyed. Three kilns collapsed and two-thirds of the manufactured and half-manufactured stock was damaged. If it is ultimately decided to resume, reconstruction will take three months.

Japan Brick Co.

Two chimneys collapsed at the Fukaya factory and one at each of the Kameido and Shiodomo Works, whilst in addition six drying rooms were damaged. All factories will be repaired by the beginning of November, and it will be possible to continue at full capacity.

Dai Nippon Cotton Spinning Co.

Factory at Hashiba. Damage was extensive, and only about 30 per cent. of the factory buildings have roofs left on them. The machinery, which can be used again, consists of 33,000 spindles and about 700 looms. Two months must pass before work can be restarted. About two-thirds of the operatives have returned to their native places, and as the remainder are dependent on the factory for food and clothing every effort is being made to restart as soon as possible. All three go-downs are safe, and there is six months' supply of raw material on hand and also some stock.

Tokyo Cotton Spinning Co.

Nisbiarai factory, manufacturing treble width calico, narrow calico, cotton thread, etc. Severely damaged; one-third of the spinning and weaving machinery cannot be used, and work cannot be restarted for two months. Sufficient raw material is available for this year, and there is a stock of manufactured goods. Large numbers of operatives have returned to their homes.

Kanegafuchi Spinning Co.

Kanegafuchi factory. Only one of the five buildings collapsed entirely, and on the whole damage was slight. The works are busy with repairs, and one of the factories should be reopened in September and the remaining three in October. It is hoped that by October the output will be 75 per cent. of that of pre-earthquake days. An ample stock of raw material and manufactured goods exists.

Tokyo Muslin.

Azuma factory. One of the three factories and five dormitories collapsed. There is no prospect of repairing one of the factories, but the other two are expected to be working in a month's time. Stocks of raw material and manufactured goods exist in some quantity.

Tokyo Gas Co.

Oshima Clay factory, manufacturing benzol, toluol, creosote, sulphate of ammonia, naphthalin, etc., by the decomposition of coal tar by steam. Little damage suffered, and early resumption is anticipated. Stocks are available.

Eastern Asia Flour Co.

Oshima factory. Damage slight; operations were resumed September 14, though maximum capacity could not be attained on account of lack of motive power. There is a fear of shortage of raw materials. There are no longer any stocks, as they were distributed after the earthquake.

Japan Flour Manufacturing Co.

Factory at Sago-cho; little damage and prospect of early reconstruction.

The opening of the company's new factory, which was being built at Yokohama, and which was to have been completed in November this year, must be postponed.

Owing to lack of local transport facilities by rail and water, the factory's output will have to be curtailed.

Japan Bristles Co.

Kobinata-cho factory. Bleachers of domestic and imported Chinese pigs' bristles and manufacturers of brushes. Almost entirely destroyed, with little prospect of restoration. Stocks practically all lost.

Maruzen Ink Manufacturing Co.

Komagome (Tokyo) factory, manufacturing writing ink and liquid Indian ink. Damage slight, and operations have already been resumed. There are considerable stocks.

Three S's Fountain Pen Factory.

At Ikebukuro (Tokyo suburbs). The godowns were burnt and the stock was mostly lost. Repairs are being carried out quickly, and there is a prospect of reopening early in October.

Nagamine Celluloid Co.

Kameido factory of 250 tsubo collapsed. The former go-downs will probably be used as a factory. The manufacturing machinery and appliances were only slightly damaged, and it will probably be possible to restart from October 1, but complete reconstruction will take two or three months. There are stocks of both raw materials and manufactured goods.

Oriental Oxygen Manufacturing Co.

At Osaki factory there was no damage to buildings or machinery, but there was a great loss of containers, and about 700 pumps were destroyed by fire. Every effort is being made for speedy reconstruction with no diminution of output.

Tanabe Oxygen Manufacturing Co.

The factory at Oshima was not damaged, but a large number of containers was lost.

Japan Oxygen Manufacturing Co.

Factories at Osaki and Kameido. There was practically no damage at the former, and there is a possibility of early restoration, but at the Kameido factory wooden go-downs were destroyed and 1,200 containers were lost. As soon as motive power is available work can be restarted, but in view of the shortage of containers there must be a decreased output.

Department of Overseas Trade,
35, Old Queen Street,
London, S.W.1.
December, 1923.

THE METALLURGICAL ASPECT OF THE PRODUCTION OF COLD.

By Cosmo Johns.

Most of the useful metals in present-day practice are extracted from their ores, and refined for the use of man, by processes which involve the use of atmospheric air for the combustion of carbonaceous matter, silicon, phosphorus or sulphur to provide the heat required. These processes have become standardised to a large extent, and are based on the assumption of the invariableness of the oxygen content of the atmosphere. Until Gayley, not so long ago, demonstrated that the seasonal variations in the aqueous vapour content of the atmosphere could be controlled in the air blown into the blast furnace by refrigeration, it had been assumed that the fluctuating aqueous vapour content of the atmosphere was beyond human control in metallurgical operations on a commercial scale. To-day the assumption of invariability in the oxygen ratio of the air used is firmly rooted in the minds of those who are operating metallurgical plants.

Obviously the oxygen enrichment of the air used would alter the conditions under which those metallurgical processes which depend on oxidation of some fuel for the heat required are carried out; and although it is difficult to predict what would actually be the effect of such altered conditions, yet enough is known to enable us to say that revolutionary changes in metallurgical practice would result. The processes now employed, and the types of plant used, are the result of gradual evolution of indus-

trial practice. Our knowledge of the reactions that occur are imperfect and almost entirely restricted to our knowledge of *what occurs when ordinary air is used.* But though it may be difficult to predict the actual changes in practice that would result, it is comparatively easy to review the possibilities. It is important to note, however, that what is contemplated is not the use of pure oxygen, but the availability *of a mixture with 30 to 40 per cent.* oxygen or even less.

The modern blast furnace plant would obviously undergo a startling change in its design and arrangement when it had no longer to handle the present huge volumes of dust laden heated combustible gases, to effect difficult heat exchanges with the incoming air, to secure fuel economy. The hot blast stoves would probably disappear *or be much reduced in size. The furnace* itself would be reduced in height, and the whole plant, when the changes had been completed, would bear but little resemblance to the equipment found necessary to-day for the production of pig iron. The bessemer converter, whether acid or basic, *has been evolved on the assumption of an* invariable oxygen content of the air blown in. Given the possibility of varying and *controlling the oxygen ratio in the air employed,* we should find the character of the process completely changed. In the acid process it is known that the order in which *carbon and silicon are removed depends on* the temperature. In the basic process it is almost certain that by controlling the temperature it would be possible to oxidise the phosphorus before all the carbon had been removed, and thus the injurious after blow would be avoided. This temperature control could be effected if the oxygen content of the air blown in could be varied.

The regenerative open hearth steel melting furnace is costly, complicated, and inefficient from the thermal standpoint. If oxygen-enriched air could be employed for the production of the fuel gas and for its subsequent combustion in the hearth of the furnace it would be possible to effect a startling and beneficial alteration in the plant. The *uni-flow furnace* would become a possibility, and there would be a very desirable simplification in the design of the plant. A neutral or oxidising flame would be at the command of the operator while the melting and refining operations would be accelerated. The waste gas of the furnace would be much richer in CO, and with added oxygen rich air would be ideal for blowing into the gas producer, thus enabling a fuel gas rich in CO to be supplied *to the furnace.*

The possibilities of beneficial changes in the practice of copper smelting and refining would be as great as in iron and steel works practice. Pyritic smelting would lose many if not nearly all its difficulties if it were commercially possible to vary the oxygen content of the air used, while the bessemerising of copper matte would be accelerated. Most important of all would be the possi*bility that the waste gases, now difficult to* handle owing to the vast volumes of inert gas present, could be used for the recovery of their sulphur content. But it is unnecessary to pursue further this review of metallurgical possibilities once a commercial method of giving an oxygen enriched air is *available. Whether the fuel burnt be car*bon, silicon, phosphorus or sulphur, the result must be to give greater freedom to those operating the various processes and to open the way for new advances in metallurgical practice.

It is important to note that it is not pure *oxygen that is required.* It would be amply sufficient if the oxygen content could be varied between the range of 20 and 40 per cent. *The problem is, therefore, quite dif*ferent to that of preparing pure oxygen. Dr. F. G. Cotterell[1] has pointed out in his admirable review of the subject the fact that air is a mixture of oxygen and nitrogen and that the theoretical amount of energy required for the separation of the two gases is very small, in fact only about 1 per cent. of that required for the production of an equal weight of electrolytic oxygen. Now any cycle that requires energy of the order of 30 H.P. per 1,000 cubic feet of oxygen at normal pressure and temperature can be ruled out at once. What is required is not pure oxygen in steel bottles, but enriched air in hundreds of tons. It can be assumed that in this country the production of a ton of pig iron requires 140,000 cubic feet of air at normal temperature and pressure. This will serve as a measure of the quantities involved.

Owing to the slight difference in density of oxygen and nitrogen, it would appear that centrifugal methods for their separation are not very hopeful. Can any refrigerating system be devised which will give oxygen-enriched air at a commercial price? Any such refrigerating system should be able to use, as the source of the

energy it requires, the sensible or potential heat of the products of the metallurgical process where it is employed if carbon be the fuel used in that process. If a suitable cycle can be discovered for effecting the partial separation of two mixed gases, for complete separation is not required, then a vast field is available for the use of oxygen.

[1] *Chemical and Metallurgical Engineering, July 4, 1920, p. 53, et seq.*

(*From the "Transactions of the Faraday Society.*")

THE SILVER-LEAD DEPOSITS OF MAYO DISTRICT, YUKON TERRITORY, CANADA.

The silver-lead ores of the Mayo district, Yukon, have been attracting considerable attention since 1919, on account of the discovery of high grade deposits on Keno Hill.

Mayo district is situated in the eastern portion of Yukon, and may be roughly defined as the watershed of Upper Stewart river. Stewart river joins Yukon river 72 miles south of Dawson, and Mayo is situated 180 miles above the mouth of the Stewart. During the summer a regular service to Mayo is maintained by the White Pass and Yukon Railway, connecting with the Yukon river steamers. Keno Hill, the important mining centre of the district, is 42 miles north-east of Mayo. Practically all haulage between the mines and Mayo is done by sled in the winter, and ore shipments are piled at Mayo to await the opening of navigation in the spring.

The first lode mining in Mayo district was done in 1912-13, when the Silver King deposit was opened. This property was worked continuously until 1917, when the ore shoot became exhausted, and the property was closed down. Exact figures of production are not available. During the winter of 1914-15, 1,180 tons of ore were shipped, having an average content of 270 ounces per ton and 31 per cent. lead. In 1915-16 the tonnage shipped was much larger, but the grade of the ore was not as high.

In 1919 the deposits on Keno Hill were discovered and staked. The Yukon Gold Co. immediately purchased the original claims and formed a subsidiary company, Keno Hill, Ltd., to operate the property. In the winter of 1920-21 this company shipped 2,150 tons of ore having a silver content of 197 ounces per ton and lead content of 60 per cent. At the same time a 100 K.W. steam power plant was installed on Duncan Creek, with transmission line 4 miles long to the property.

In 1921, Keno Hill, Ltd., acquired the Sadie-Friendship group on the western slope of the hill, and Treadwell Yukon Co. entered the field, acquiring a group of claims adjoining the Sadie-Friendship property. During the winter of 1921-22 Keno Hill, Ltd., shipped from its original claims 3,100 tons of ore having a silver content of 224 ounces per ton and a lead content of 60.5 per cent.

During the winter of 1922-23 both companies were shipping ore, the production being 8,700 tons, from which smelter returns are not yet available, but this ore is expected to average over 200 ounces of silver per ton and 50 per cent. lead.

During the summer of 1923, the last of the known ore of shipping grade was extracted from the original holdings of Keno Hill, Ltd., although a considerable tonnage of concentrating ore remains. The property, however, has been closed down for the present, and work has been started on the Sadie-Friendship vein. On this deposit both companies are at present engaged, and workings have been carried to a depth of 300 feet without sign of diminishing values. Treadwell Yukon Co. is at present driving a drainage tunnel to tap the vein at a depth of 500 feet. This deposit will probably produce a much greater tonnage than the original discovery on Keno Hill.

The development of the district has been greatly retarded by high mining and transportation costs. The latter have been considerably reduced by the introduction of the caterpillar tractor, and the former will doubtless be reduced when concentrating plants have been built. Plans for these are now being considered. As the district is still in its early stages, further discoveries of high-grade ores can be expected. At the present time only high-grade ores can be worked, as there is not sufficient tonnage in sight to justify the erection of a smelter, and ores have to be shipped 3,000 miles or more to smelters on the Pacific Coast.

UNIVERSITY OF LONDON, UNIVERSITY COLLEGE.

In connection with the establishment at University College, London, of the Ramsay Memorial Laboratory of Chemical En-

gineering, the newly appointed Professor, Mr. E. C. Williams, M.Sc., will deliver a public inaugural lecture at University College, on "The Aims and Future Work of the Ramsay Laboratory of Chemical Engineering," on Thursday, January 17, 1924, at 5.30 p.m.

The chair will be taken by Sir Robert Robertson, K.B.E., M.A., F.R.S., who has been closely associated with the establishment of the laboratory, and who is Chairman of the Chemical Engineering Sub-Committee.

The lecture will be open to the public, and application for tickets should be addressed to the Secretary of University College.

The establishment of a Ramsay Memorial Laboratory of Chemical Engineering at University College, London, was one of the two main objects of the fund raised in memory of the late Professor Sir William Ramsay. The Committee of the Ramsay Fund found it possible to hand over to the University for University College a sum of approximately £27,000.

The Laboratory has been instituted in the first instance for an experimental period of five years, and a suitable building in Gordon Street, close to the Chemistry Laboratories, has been reconstructed and equipped so as to be available for the work of the new laboratory.

A number of firms interested in the chemical and chemical engineering industries have promised annual subscriptions for a period of five years, totalling £1,540 a year, or have given single donations amounting to £206 for the promotion of this new development in chemical teaching.

A leaflet giving particulars of the proposed work of the Laboratory of Chemical Engineering can be obtained from the Secretary, University College, London (Gower Street, W.C.1).

SIR WILLIAM BRAGG'S EXPERIMENTS AT THE ROYAL INSTITUTION JUVENILE LECTURES.

At Sir William Bragg's lecture on *The Nature of Gases*, at the Royal Institution on December 29, every available seat was filled. The lecturer explained that twenty of the ninety different kinds of atoms were represented in his models by twenty clusters of coloured balls (electrons) grouped round central indiarubber balls (the positive nuclei). Hydrogen atoms had one ball, Helium two, and so on to Calcium, which had twenty. The simplicity of the atoms is almost staggering.

He singled out the carbon atom, explaining that it had six electrons, the power of which was counterbalanced by the charge in the positive core, so that the whole was neutral. That was the essence of the atom's behaviour. The Helium, Neon, and Argon atoms he described as "unsociable." They have no attraction for any other atom and do not even attract one another.

That was the nature of the atoms of gas. That was why Helium was the best thing for filling Zeppelins. If we filled them with hydrogen, which had not this unsociability, then they might come near oxygen atoms. There would be mutual attraction, a spark, and an explosion. Lord Rayleigh discovered Argon gas atoms when experimenting with the constituents of the atmosphere. Sir William demonstrated the rapid movements of the various gas atoms by a table full of billiard balls!

Then Sir William filled a cylinder attached to a vacuum pump with purified air, like country air. On the vacuum being released it created a faint wisp of mist. Then he let in some air from the room. It created a thick fog which completely filled the cylinder, owing to dust particles being present.

To illustrate how sound travels more quickly through hydrogen than oxygen, because their respective atoms are moving at different speeds, the lecturer held a vibrating tuning fork over a glass tube filled first with air, then gas, then a stream of water, the sound becoming increased each time.

The air around us, he explained, exerted a pressure of 15 lbs. to the square inch. Whereupon he brandished a 15-lb. bar of iron and banged the end on the table. "On every inch of our bodies there is a weight equal to this bar. Why don't we collapse?" The answer was at once provided by a brown indiarubber cupid in a picture hat, who, immediately the air was withdrawn from within it, *did* collapse. A tin can, similarly treated, followed suit.

Sir William then demonstrated how, when all air pressure was removed, a sixpence and a flimsy piece of paper would fall down a vacuum tube at the same rate. In illustrating, finally, the rebound movements of propelled bodies, from atoms to tennis balls, he manipulated racquet, golf club, and wooden bat with great dexterity.

THE NATURE OF LIQUIDS.

WHY DOES OIL MAKE THE SEA SUBSIDE?

In his lecture, on Tuesday, January 1, Sir William Bragg poured oil on the troubled waters—just a few almost imperceptible drops.

The waters were stilled. The Atlantic Ocean, potted in a glass tank for the sake of observation, was being lashed into fury by air through a pipe. The howl of the gale was heard and seen, the little mountainous waves chasing one another.

Sir William sprinkled a few drops of oil into the tank and the gale subsided.

Now this is the scientific explanation as given by the lecturer. There are many molecules of a very peculiar form. They are very long compared to their width. The central part is a chain of carbon atoms and there are what we may call finials at each end. The long chain molecules of which the oil consists jump quickly into side by side positions on the surface, something like a line of policemen linked arm in arm holding back a crowd.

The finial which is attracted by the water takes root in it, and the long molecules stand up like the pile of velvet linked together side by side. The other finials present a surface to the air, which moves over it with very little friction. Thus a wind does not really still the waves, but it prevents the wind from increasing and maintaining them, and the waves die down when they have spent their energy by internal friction."

Then there was an experiment with toy ships propelled by dissolving camphor. Sir William launched three tiny boats in a bath, and asked the audience to note how the camphor placed at the stern drove them through the water as it dissolved.

What unsociable little fellows certain atoms can be and how others love to cling together like the ivy on the wall! Atoms of oxygen were difficult to obtain alone; they went about in pairs. Other atoms played a sort of game when combining chemically, and there was a rule of eight. Strangely enough, an atom tried to draw a shroud of eight electrons round itself.

Cooling by evaporation was used by nature to prevent our bodies from becoming overheated. The surgeon caused local freezing by sprinkling with a spray of some very volatile liquid. Drinking water was cooled in hot, dry countries by hanging [illegible] shaded from the sun and yet the hot wind could blow on it.

Sir William also illustrated the principle of the "water hammer." Water was admitted into a vacuum tube, when it rushed to the end, making a loud noise because there was no air to stop or deaden the force of the blow. Experiments were made with liquid air. Real grapes were turned into iced grapes in a second—hard and brittle.

THE NATURE OF CRYSTALS.

Explaining X-Rays and the Atom.

On Thursday, January 3, Sir William Bragg showed his audience two of the mysteries of the Royal Institution. The first was a large lump of quartz, about a foot high, the second a glass bottle full of barnacles.

"I've a personal grudge against this lump of quartz," he said. "It stands on the window-sill in the lecturer's room, and anyone coming to the Royal Institution to give a lecture is practically forced to contemplate it. I can't tell you why it is there. No one in the Institution knows why it is there, or who put it there. The other ornament of the lecturer's room is this pot of barnacles."

He contemplated these two and added: "I can't look at them now without feeling awkward."

NATURE OF CRYSTALS.

The lecture was on the nature of crystals. Some very beautiful experiments were carried out with polarised light, when the juveniles were able to watch crystals growing before their eyes. They appeared as shifting patterns of glowing colour. Some were gay with gold and crimson, like Chinese embroideries, others as delicate as the colours of Italian mural paintings.

He next explained in simple language the deep mystery of X-rays and the atom. He had model X-rays made from lead, and compared the X-rays to phantom rows of policemen marching along an endless beat and all turning down the same street in step with one another.

A diamond is hard because the atoms are so perfectly arranged. They are so comfortable that if you press a diamond on something else, it is the other atoms that have to shift.

He revealed the fact that although a diamond is so hard, it may be broken through dropping it on the floor, and that cases have been known where diamonds have simply burst into pieces.

Sir William's final point was a dramatic and generous tribute to Faraday, the founder of this series of lectures. Pointing to the ring of six atoms in the diamond model, he said: "That is the diamond's ring of six, the ring of benzene. Faraday discovered that by one of the most beautiful pieces of human reasoning. It is the basis of organic chemistry."

He picked up a tiny bottle. "And here in this bottle are just a few drops of benzene. Faraday bottled them. They were the first he made nearly one hundred years ago."

Ice and Snow Crystals.

On Saturday, January 5, in lecturing on "Ice and Snow Crystals," Sir William was handling ice for the best part of an hour.

Beautiful as jewels, medallions, fern fronds, and six-lobed blossoms were the diagrams of snow crystals thrown on the screen. The shapes varied according to the circumstances of their formation. But all were hexagonal, with spaces separating the molecules, which made the crystals look like a beautiful pattern of lacework in space. It was because of the emptiness of this ice structure that snow flakes were so light and feathery. A delicate masterpiece was a reproduction of frost figures on a window pane, taken in the Antarctic.

Sheets of ice were then placed in the lantern, and the audience watched the crystals breaking up in the heat of the light-ray. As they melted they formed themselves into the same six-lobed pattern.

Illustrating how ice crystals could be melted by pressure, a wire was shown attached to weights gradually cutting through a block of ice. Immediately, however, the water above the wire froze again, so that the block was "cut in two and yet whole."

Haloes and mock-suns, those deceiving phenomena of the Arctic regions, were manufactured to order merely by refracting a ray of light in the prism of ice crystals. Liquid air was poured into a bath of water, and it at once formed a series of ice-boats on the surface, each carrying the remains of the liquid air. For the moment it resembled a smoking Battle of Jutland. Artistic little "cut glass' crystal goblets were moulded in a press from crushed ice.

The power quartz has of rotating the plane of polarisation of light, which seems to travel on a screw as it passes through, was shown on the screen, the reflected colours changing fro mvivid orange to red, yellow, green, and blue, as the quartz revolved. Tartaric acid has the same property, the lecturer explained. Pasteur's surmises in regard to this screw-like molecular structure were the first step in his brilliant and most famous career. X-rays had since shown him to be right.

"During the last quarter of a century," said Sir William, "radioactivity and X-rays have given us a new view of nature altogether. It is sometimes said this is the Elizabethan age of physics. But the advances made during these twenty years are only a small part of what will be done before long. It is as though we had broken away through difficult country, and on the the other side was a range of hills which opened a new prospect for us. Through crystals, which are nature's first and best effort to put atoms into patterns, we understand more about the inner constitution of the atom. X-rays give us a vision ten thousand times keener than ordinary light. Our whole bodies are a mass of atoms, and the biologist and physiologist stand to learn by the new knowledge as much as the maker of steel."

EXHIBITION OF APPARATUS.

The fourteenth annual exhibition of electrical, optical and other physical apparatus arranged by the Physical Society of London and the Optical Society, was held at the Imperial College of Science on January 2 and 3, 1924. Two lectures were delivered on each of the two days: one by Mr. B. Grylls on "The Heape and Grylls Rapid Cinema Machine," and the other by Sir Richard Paget on "The Nature and Artificial Production of Human Speech." There were some 51 trade exhibits, ranging over many types of physical instruments. Apart from these, scientific books were shown by the Cambridge University Press, H. K. Lewis & Co., and the Wireless Press, Ltd., and Mr. J. Rheinberg had an exhibit of colour designs on paper and textiles by single printing on backgrounds of uniform tints.

A variety of microscopes and accessories was shown. C. Baker's exhibit included an ultra condenser for the examination of liquids and gases and a new reflex drawing apparatus; demonstrations were given of the preparation of microscope objects. R. & J. Beck, Ltd., had a Beck Mas

microscope with high-power focussing dark ground illuminator, a Leubeck projection micrometer for the rapid measurement of wires and fibres to 1/50,000 inch, and a Beck Radial research microscope and outfit. Ogilvy & Co. showed a variety of electric microscope lamps, a binocular attachment for monocular microscopes, and a combined metallurgical microscope and camera with vibration absorber. W. Watson & Sons exhibited a universal binocular microscope body for use with all objectives, the light in both tubes being equal in luminosity, ocular fatigue is obviated, and there is no loss in resolving power or definition; a Nelson's new Cassegrain dark ground illuminator oil immersion objectives of 1.3 and 1.4 N.A. to be used with a black background without a funnel stop; and a series of ten colour filters of constant colour value covering all wave-lengths from 4,300 to 7,000. F. Davidson & Co.'s exhibit included the Davon super-microscope.

Photographic apparatus was shown by J. H. Dallmeyer, Ltd., who gave a kinema demonstration of the making of a photographic lens; by Ross, Ltd., amongst whose exhibits was the Ross Kinematograph Projector with a Ross high intensity searchlight arc lamp; and the Cambridge and Paul Scientific Instrument Co., who showed various cameras for laboratory record work, and amongst whose exhibit was a stress recorder which automatically marked diagrams upon transparent celluloid, a vibrograph showing road movements caused by traffic, and an outfit for automatic control of temperature of a gas-fired furnace.

Other optical apparatus was shown by Newton & Co., and A. Gallenkamp & Co., whose exhibit included apparatus for electrometric, acid alkali, and oxidation titration, and J. Griffin & Sons, who showed an optical bench and also a "Fletcher" micro-furnace for the rapid qualitative analysis of metals, ores and metallic salts. Adam Hilger, Ltd., showed various spectrometers and polarimeters. Some publications from Hilger's research laboratory were shown, and an especially interesting feature to readers of *The Chemical News* was a photograph of the Hafnium Spectrum, taken on a Hilger spectrograph, on which also photographs were taken to determine the wave-lengths of the Hafnium lines. Bellingham & Stanley, Ltd., also showed polarimeters and spectrometers, and a refractometer in which the usual silvered glass mirror was replaced by one of stainless steel.

Not unnaturally, the present prominence of wireless work was reflected in the majority of electrical exhibits. The Dubilier Condenser Co. showed many kinds of condensers. Marconi's Wireless Telegraph Co. showed their magnetic drum recorder, by which telegraphic signals have been recorded at a speed of 650 words per minute, and the Marconi Otophone for the use of deaf people. The M.O. Valve Co. showed types of loud speaker, receiving and transmitting valves, and the Mullard Radio Valve Co. had a similar exhibit. The Edison Swan Electric Co. showed their Pointolite lamps, ranging from 30 to 4,000 candle power D.C., and one for A.C. of 150 candle power.

Many measuring, mathematical and surveying instruments were exhibited. Carbric, Ltd., showed a King's patent calculator; C. F. Casella & Co. had an automatic air filter for measuring suspended atmospheric impurities. Negretti & Zambra's showed some new hair hygrometers, and L. Oertling, Ltd., showed some balances, including one for ascertaining moisture in tobacco and an Eotvos Gravity torsion balance used for locating irregularities in the earth causing gravitational anomalies.

Other exhibits were a selenium magnifier for submarine telegraphy, by H. W. Sullivan, Ltd.; a "Dionic" water-tester, which by measurement of the electrical conductivity determines the amount of inorganic impurity dissolved in water, by Evershed & Vignoles; chemically engraved name and diagram plates in different colours, by Elliott Bros.; the Damard Lacquer Co. showed a number of electrical insulating products; H. Kennedy & Co. showed an Elverson Oscilloscope for investigating the behaviour of machinery under working conditions; and X-ray apparatus was shown by Watson & Sons (Electro-Medical), Ltd.

E.H.E.

GENERAL NOTES.

PHOTOGRAPHIC MATERIAL FOR EGYPT.

The Ministry of Interior, Egypt, is calling for tenders, to be presented by noon on March 15, for the supply for the year 1924 of various photographic materials, including apparatus and accessories, plates,

paper, cinematograph film stock and apparatus, and miscellaneous chemicals.

Local representation is essential.

The conditions of tender, specification, etc., can be inspected by United Kingdom firms interested at the offices of the Department of Overseas Trade (Room 53), 35, Old Queen Street, London, S.W.1.

ENQUIRY FOR CAUSTIC SODA AND SODA ASH.

The officer in charge of the office of H.M. Trade Commissioner at Winnipeg reports that a Canadian firm of soap manufacturers are desirous of receiving quotations for soda ash and caustic soda from United Kingdom manufacturers of heavy chemicals. The firm use about 1,000 tons of each commodity per annum.

Reference: 12842/E.D./C.C.(2), Dept. of Overseas Trade.

INTERNATION PHYSICAL CHEMISTRY.

Beginning with January, 1924, *The Journal of Physical Chemistry* becomes an International Journal, and will be published under the auspices of the American Chemical Society, the Chemical Society of London, and the Faraday Society. These three societies nominate the Board of Editors and the Board elects its own editor-in-chief. For 1924 the editor-in-chief will be Prof. W. D. Bancroft, and the associate editors will consist of A. L. Day, F. G. Donnan, G. A. Hulett, Irving Langmuir, T. M. Lowry, J. W. McBain, W. L. Miller, and J. C. Philip.

The subscription price will be $10.00 per year. $8.00 to members of any one of the three societies who subscribe direct.

PROCEEDINGS AND NOTICES OF SOCIETIES.

THE GEOLOGICAL SOCIETY OF LONDON.

A meeting was held on December 19, Prof. A. C. Seward, Sc.D., F.R.S., President, in the chair.

Prof. William Johnson Sollas, Sc.D., F.R.S., F.G.S., gave a demonstration of the Method of Investigating Fossils by Serial Sections, illustrated by specimens, photographs, and lantern-slides.

Mr. John Walton, M.A., gave a short lecture on the Investigation of the Nature of Fossil Plants, illustrated by lantern-slides and microscopic preparations.

Prof. Herbert Leader Hawkins, D.Sc., F.G.S., exhibited and commented upon Anatomical Preparations of Fossil Echinoids.

A meeting of the Society was held on January 9, when the following communications were read:—

The Geological Structure of the Clevedon-Portishead Area (Somerset), by Prof. S. H. Reynolds, M.A., Sc.D., F.G.S., and Dr. E. Greenly, F.G.S.

The Avonian of the Tytherington-Tortworth-Wickwar Ridge (Gloucestershire), by Dr. F. S. Wallis, F.G.S.

The Avonian of the Western Mendips, from the Cheddar-Valley Railway to the Sea, West of Brean Down, by Miss Agnes E. Bamber, M.Sc. Communicated by Prof. S. H. Reynolds, M.A., Sc.D., F.G.S.

THE INSTITUTION OF ELECTRICAL ENGINEERS.

A joint meeting with the Societe des Ingenieurs Civils de France (British Section was held on January 10. There was a continuation of the discussion on M. A Bachellery's paper on *The Electrification of the Midi Railway.*

THE INSTITUTION OF PETROLEUM TECHNOLOGISTS.

A general meeting was held at the hous of the Royal Society of Arts, John Stree Adelphi, W.C.2, on Tuesday, January 8 The following papers were read:—

The Crude Oil of Sarawak, by Jami Kewley, M.A., F.I.C., F.C.S., and *Th Crude Oil of Maidan-i-Naftun,* by A. Dunstan, D.Sc., F.I.C., F.C.S.

NOTICES OF BOOKS.

Lead, by J. A. Smythe, Ph.D., D.Sc. Pp. VI. + 348. 1923. Messrs. Longmans, Green & Co., 39, Paternoster Row, E.C.4. 16s. net.

As one of the series of monographs on Industrial Chemistry, published under the general editorship of Sir Edward Thorpe, Dr. Smythe has compiled a valuable volume on the Chemistry and Metallurgy of Lead. The occurrence of the metal in nature, its extraction, properties, compounds, and uses are fully described, and there is a brief introductory survey of the voluminous history of the metal, which is widely distributed in nature.

The chemical nature of the reactions involved in the roasting and smelting of the ores is more complicated than is generally recognised, and Dr. Smythe has traced these for the different ores used. The method for converting Galena into the metal is usually termed a roasting and reaction process. Part of the galena becomes converted into oxide and sulphate:—

$$PbS + 3O = PbO + SO_2$$
$$SO_2 + O = SO_3$$
$$PbO + SO_3 = PbSO_4$$

These then react with the rest of the sulphide:—

(1) $PbS + PbSO_4 = 2Pb + 2SO_2$

(2) $PbS + 2\,PbO = 3Pb + SO_2$.

Lead obtained by smelting operations contains variable amounts of silver (and other metals).

The desilvering processes of Pattinson and Parkes are described from the technical and the theoretical standpoints.

The chemical and physical properties of lead and its uses have received adequate mention, and it is pointed out that whilst determinations of the Atomic Weight of specimens of ordinary lead give consistent results, lead from pitchblende (*i.e.*, from a radio-active Uranium mineral) had an Atomic Weight of not much more than 206, but that from Thorium minerals was over 208.

The alloys and the compounds of the metal are discussed in the light of modern knowledge and the most recent work on the subject, such as that of Glasstone on the oxides, has been taken into account.

The monograph concludes with an informative chapter on lead poisoning, and it is interesting to note that the indexes run into 30 pages.

The author has succeeded in presenting a very good outline of our somewhat limited knowledge of the chemistry of this metal.

A Course in General Chemistry, by William C. Bray and Wendell M. Latimer. Pp. VIII. + 148. 1923. New York: The Macmillan Company.

This introductory course of qualitative inorganic analysis is based upon that adopted at the University of California during the last two years, and aims rather at method than mere facts. The theoretical work in chemistry has not been ignored in the drawing up of this practical course.

The course outlined in this volume is divided into sections which are sub-divided into "assignments." These are intended to indicate and state the object of the particular experiment or experiments under consideration. This course covers a wide range of chemical reactions treated from the standpoint of the ionic theory.

It is apparently intended to replace or lead up to the usual systematic qualitative analysis. In some ways it has advantages over the older methods of presentation, especially for students with a fair general knowledge of elementary science.

There are, however, a number of criticisms to which it lays itself open. The experiments given are those usually termed "test-tube" experiments, and students whose practical course for a whole year consists of nothing else, and finally attain to the very limited scheme of analysis outlined in the last three assignments would not feel very satisfied with their work on the subject. It is also very doubtful whether the "gifted student" would be kept busy at his own level by allowing him to work slightly ahead of the rest.

As regards actual chemical facts, the book is quite sound, but it seems superfluous for the authors to introduce a further grouping of the metals, in which copper and silver are placed together in a Group III.

A Course of Laboratory Experiments on Physico-Chemical Principles, by Miles S. Sherrill. Pp. X. + 125. 1923. New York: The Macmillan Company.

This Practical Physical Chemistry gives an account of the procedure for conducting most of the usual experiments included in a laboratory course on the subject.

It is noticeable that the experiments have been chosen to avoid the use of expensive and complicated apparatus, and the work in electro-chemistry has been reduced to a bare minimum.

understand the principles involved in the

Students who complete the course and

experiments would have gained a fair general acquaintance with the outlines of Physical Chemistry.

The book will be of service to lecturers and demonstrators in this subject, particularly when they are framing experiments to illustrate certain phenomena.

BOOKS RECEIVED.

The Physical Chemistry of the Photographic Process.—A General Discussion held by THE FARADAY SOCIETY, May, 1923. Pp. 244 to 405. 1923. The Faraday Society, 10, Essex Street, Strand, W.C.2. 12s. 6d. net.

The Electronic Theory of Valency.—A General Discussion held by THE FARADAY SOCIETY in July, 1923. Pp. 451 to 543. 1923. The Faraday Society, 10, Essex St., Strand, W.C.2. 10s. 6d. net.

General Chemistry An Elementary Survey, by HORACE G. DEMING, Professor of Chemistry, University of Nebraska. Pp. XII. + 605. 1923. Messrs. Chapman & Hall, 11, Henrietta Street, Covent Garden, W.C.2. 17s. 6d. net.

Quantitative Chemical Analysis, by FRANK CLOWES, D.Sc. (LOND.), and J. BERNARD COLEMAN, A.R.C.Sc. (Dublin). Pp. XXIV. + 576. Twelfth Edition, 1924. Messrs. J. & A. Churchill, 7, Great Marlborough Street, W.1. 18s. net.

Allen's Commercial Organic Analysis, Edited by SAMUEL S. SADLER, S.B., ELBERT C. LATHROP, A.B., PH.D., and C. AINSWORTH MITCHELL, M.A., F.I.C. Pp. VI. + 795. Vol. I. 1924. Messrs. J. & H. Churchill, 7, Great Marlborough St., W.1. 30s. net.

The fate of the French airship *Dixmude* has engaged public attention since its last S.O.S. call on December 22.

From the discovery of a petrol tank belonging to the airship, showing signs of fire, and other charred débris reputed to have been part of the ship, it seems probable that the Dixmude either caught fire or was struck by lightning and fell into the sea.

The latter suggestion receives support from the information that Sicilian villagers saw huge balls of fire appear in the sky after a thunderstorm on the evening in question.

The matter is of scientific interest in view of the remarks on fire-balls appearing in a communication in the previous issue of *The Chemical News* (this Vol., p. 7).

New Patents.

THIS list is specially compiled for *The Chemical News* by Messrs. Rayner & Co., Registered Patent Agents, of 5, Chancery Lane, London, *from whom* all information relating to Patents, Trade Marks, *and Designs can be obtained gratuitously.*

Latest Patent Applications.

32209—23310.—Blumenfield, J. — Titanium compounds. Dec. 22.

31627—Brutzkus, M.—Process of effecting chemical reactions in solutions. Dec. 17.

31616—Dick, Son & Lewis.—Sulphuretted hydrogen apparatus. Dec. 17.

31979—Heis, L.—Chemical conversion of substances. Dec. 20.

31879—Wibaut, J. P. — Manufacture of alkyl halides. Dec. 19.

Abstract Published this Week.

206284—Titanium compounds: pigments.—Buckman, H. H., of 130, Copeland Street, Jacksonville, Florida, U.S.A.

Titanium oxide and salts.—Insoluble titanium compounds suitable for pigments and for fillers for linoleum, rubber, and plastics, are obtained by treating a titanium ore or product such as *rutile or ilmenite, after grinding and preferably* water or air flotation, with sulphuric acid at high temperature and pressure, a pressure of 200 lb. per sq. in. being mentioned. After the reaction water is added, and the high pressure and temperature are again imposed. The products are an insoluble titanium compound and a solution containing the iron and some titanium. If a very white product is desired some phosphate rock is mixed with the ilmenite or rutile, or may be added with the water after the acid treatment, but the quantity must not be so great as to destroy the acidity of the solution. When *a mixed pigment* is desired a compound such as gypsum or barium sulphate may be added to the initial charge, or calcium carbonate or hydrate to the reaction mixture when adding the water, but the acidity of the solution must not be destroyed. The products may be used after washing and drying, or may be calcined at a dull red heat.

Messrs. Rayner & Co. will obtain printed copies of the published specifications and abstract only, and forward on post free for the price of 1s. 6d. each.

UNIVERSITY OF LONDON, UNIVERSITY COLLEGE.

CHEMICAL ENGINEERING.

PROFESSOR E. C. WILLIAMS, M.Sc., will deliver a Public Inaugural Lecture on

"The Aims and Future Work of the Ramsay Memorial Laboratory of Chemical Engineering," at University College, on January 17th, 1924, at 5.30 p.m.

CHAIRMAN: SIR ROBERT ROBERTSON, K.B.E., M.A., F.R.S.

Applications for tickets for this Lecture should be *made to the undersigned.*

The Courses of Instruction and Laboratory Work in Chemical Engineering will begin on January 15th, 1924.

WALTER W. SETON,
Secretary.
University College, London
(Gower Street, W.C.).

THE CHEMICAL NEWS,

VOL. CXXVIII. No. 3327.

THE PREPARATION AND PROPERTIES OF ORGANIC STANNICHLORIDES.

PART VI.—THE ACTION OF SULPHURIC ACID ON CERTAIN STANNICHLORIDES. THE FORMATION OF STANNISULPHATES.

By J. G. F. DRUCE, M.Sc. (LOND.), R.NAT.DR. (PRAGUE).

Weinland and Kuhl (*Zeitschr. anorg. Chem.*, 1907, LIV., 244) obtained a number of inorganic double sulphates of tin by dissolving the metal sulphate and α-stannic acid in concentrated sulphuric acid, and then slowly evaporating the excess of acid.

This method has now been found to be applicable for the preparation of certain of the organic stannisulphates. Also the stannichlorides of aniline, m-phenylene diamine, and quinoline have been converted into the corresponding stannisulphates by the action of concentrated sulphuric acid. When this is poured on to the stannichloride there is an effervescence and an evolution of hydrochloric acid gas. The reaction which takes place may be represented:—

$$B_2H_2SnCl_6 + 3H_2SO_4 = B_2H_2Sn(SO_4)_3 + 6HCl.$$

The stannisulphate remains in the excess of sulphuric acid. By the addition of ether and standing, the double tin sulphate crystallises out.

The stannisulphates described in the present communication are very deliquescent salts, which are decomposed by water and by alkalis. Although only three organic double tin sulphates have so far been obtained, others could doubtless be prepared by the same method.

EXPERIMENTAL.

Aniline Stannisulphate, $(C_6H_5.NH_2)_2$-$H_2Sn(SO_4)_3$.

Concentrated sulphuric acid (5 cc.) was added to 2 grams of aniline stannichloride in a boiling tube. There was a considerable evolution of hydrochloric acid gas for some minutes. After this had subsided the mixture was gently warmed and then cooled in a desiccator. No crystals separated, so about 50 cc. of dry ether were added with shaking. After some hours greyish crystals began to form. These were filtered off, washed with dry ether, drained and dried on a porous tile in a desiccator.

On analysis:

0.4213 gr. gave 0.4990 gr. $BaSO_4$;
SO_4 = 48.8 per cent.
0.5687 gr. gave 0.1306 gr. SnO_2;
Sn = 18.1 per cent.

$(C_6H_5.NH_2)$ $H_2Sn(SO_4)_3$ requires Sn = 19.7 and SO_4 = 48.6 per cent.

The salt deliquesced readily on exposure, and was decomposed by water, especially when hot. It dissolved in warm sulphuric acid.

When methyl-aniline stannichloride and o-toluidine stannichloride were treated in the same way with concentrated sulphuric acid and ether added, no precipitate appeared, neither did any crystals separate on standing.

Similarly, no dimethyl-aniline stannisulphate could be isolated in a pure state, although a small amount of a pale brown precipitate was obtained on adding ether to the solution of the stannichloride in concentrated sulphuric acid. In other experiments, alcohol, ethyl acetate, carbon tetrachloride and benzene were added to sulphuric acid solutions of these stannichlorides, but no double tin sulphate was obtained with the aid of these diluents.

m-Phenylene diamine Stannisulphate, C_6H_4 $(NH_2)_2.H_2Sn(SO_4)_3$.

This salt was readily obtained in the same manner as the aniline compound. It was soluble in water without complete decomposition. On heating, it did not melt below 300°, but in air it burned with a slight intumescence, at temperatures below red heat.

On analysis:

0.5303 gr. gave 0.1531 gr. SnO_2;
Sn = 22.7 per cent.
0.1707 gr. gave 0.2261 gr. $BaSO_4$;
SO_4 = 54.6 per cent.

C_6H_4 $(NH_2)_2.H_2Sn(SO_4)_3$ requires Sn = 23.0 and SO_4 = 55.7 per cent.

Quinoline Stannisulphate, $(C_9H_7N)_2$-$H_2Sn(SO_4)_3$.

The quinoline salt was obtained in the form of colourless, deliquescent needle crystals on adding excess of ether to the solution obtained by the interaction of sulphuric acid and quinoline stannichloride,

When alcohol was used instead of ether, no crystals separated.

When dried on a porous tile in a desiccator, the substance melted at 124°; it was soluble in water, and the solution was not completely hydrolysed on boiling. Organic solvents did not readily dissolve the crystals.

On analysis:

0.1871 gr. gave 0.0449 gr. SnO_2;
Sn = 18.9 per cent.
0.2827 gr. gave 0.3074 gr. $BaSO_4$;
SO_4 = 44.0 per cent.

$(C_9H_7N)_2\ H_2Sn(SO_4)_3$ requires Sn = 17.8 and SO_4 = 43.2 per cent.

The aniline and quinoline salts were also obtained by dissolving aniline (or quinoline) sulphate and stannic acid in concentrated sulphuric acid, and then adding ether to allow the double salt to crystallise. The stannisulphates so prepared were identical with the products obtained by the above procedure.

NOTE ON POTASSIUM AND CALCIUM STANNISULPHATES.

Potassium stannisulphate was prepared by dissolving five grams of potassium stannichloride in ten ccs. of sulphuric acid. The powdered stannichloride dissolved gradually on warming. The stannisulphate separated in the form of fine deliquescent needle crystals after the addition of ether and standing.

On analysis:

0.4840 gr. gave 0.1514 SnO_2;
Sn = 24.6 per cent.
0.4840 gr. gave 0.1715 K_2SO_4;
K = 15.9 per cent.
0.5263 gr. gave 0.7370 $BaSO_4$;
SO_4 = 57.7 per cent.
0.5263 gr. gave 0.2107 K_2SO_4;
K = 17.9 per cent.

$K_2Sn(SO_4)_3$ requires K = 16.08, Sn = 24.53 and SO_4 = 59.39 per cent.

The salt obtained by dissolving stannic acid and potassium sulphate (or hydrogen sulphate), together in concentrated sulphuric acid, and crystallising with the help of ether, was found to be identical with the product obtained from the stannichloride.

Calcium stannisulphate was prepared similarly, except that no special steps were taken to exclude the access of moisture since this salt, which crystallised in colourless cubes, contained water of crystallisation.

On analysis:

0.5340 gr. gave 0.1581 gr. SnO_2;
Sn = 23.3 per cent.
0.5340 gr. gave 0.7706 gr. $BaSO_4$;
SO_4 = 65.8 per cent.

$CaSn(SO_4)_3.3H_2O$ requires Sn = 23.75 and SO_4 = 57.5 per cent.

Weinland and Kuhl (*loc. cit.*) have isolated the following inorganic stannisulphates:—

$K_2Sn(SO_4)_3$;
$Rb_2Sn(SO_4)_3$;
$Ag_2Sn(SO_4)_3.3H_2O$;
$CaSn(SO_4)_3.3H_2O$;
$SrSn(SO_4)_3.3H_2O$;
$BaSn(SO_4)_3.3H_2O$;
$PbSn(SO_4)_3.3H_2O$;
$CeHSn(SO_4)_4$;
$Y_2Sn(SO_4)_5$;
$ThSn(SO_4)_4.2H_2O$;
$Bi(OH).Sn(SO_4)_3$.

These authors point out in their communication that the existence of these stannisulphates supports Werner's views on valency. The atom of tin can always be regarded as having a co-ordination value of six, characteristic of the quadrivalent elements in Group IV. of the Periodic Classification.

It is further of interest to note that Brauner (*Zeitschr. anorg. Chem.*, 1904, XXXIX., 261) has prepared double cerium sulphates, especially compounds of cerium sulphate with the sulphates of the rare earth metals, *e.g.*:

$$LaHCe(SO_4)_4.12H_2O.$$

These are compounds of quadrivalent cerium, which is also a member of the fourth group in the Periodic Classification. The stannisulphates are thus analogous with the double cerium sulphates.

STUDIES IN THE REACTIONS OF THE AMINO GROUP IN 4′ AMINO 1 PHENYL 5 METHYL BENZOTHIAZOLE.

PART I.—CONDENSATION OF DEHYDROTHIOPARATOLUIDINE WITH CARBON DISULPHIDE CHLOROFORM AND ALCOHOLIC POTASH, BENZALDEHYDE, ACETALDEHYDE, FORMALDEHYDE IN THE PRESENCE OF ETHYL ALCOHOL

BY R. F. HUNTER, F.C.S.

The five-membered nitrogen sulphur ring systems are of both academic and technical

interest. The bicyclic six-five fused ring systems of this class, or benzothiazoles, owe their technical importance to the fact that some of the finest azo dyes contain a ring system of this type.

4′ Amino 1 phenyl 5 methylbenzothiazole (1) is of particular interest, since it contains the homocyclic benzene ring fused to the substituted thiazole ring in the para position, the benzene ring being substituted by methyl at the position 5, and is further the well-known dye intermediate of commerce: dehydrothioparatoluidine, from which the thiazole dyes are prepared.

The presence of the benzothiazole system must clearly have a considerable effect on the amino group in the para substituting phenyl in (1), thus from the work of Hoffman on the parent substance, phenyl benzothiazole, or as Hoffman called it, "rosenkorper," we can fairly assume that the thiazole ring to a certain extent functions as an odorophore, hence in the formation of a derivative of dehydrothioparatoluidine, such as a quinoline (2), which has been prepared by Meyer (*op. cit.*), and at a later date by the author, we should have a body whose odour is the resultant effect of, firstly, the tertiary nitrogen atom in the quinoline nucleus, and secondly of the odour produced by the presence of the phenyl benzothiazole system of Hoffman. This is found to be the actual case, though the former effect is stronger than the latter.

$$CH_3C_6H_3 <^{S}_{N}> C\ C_6H_4NH_2$$

(1)

$$CH_3C_6H_3 <^{S}_{N}> C\ C_9H_8N$$

(2)

The presence of the substituted benzothiazole system in dehydrothioparatoluidine will also affect the chemical reactivity of the amino group. Thus, although aniline reacts almost instantaneously with chloroform and alcoholic potash to give the phenylcarbylamine, one could scarcely expect the reaction to proceed with the same smoothness in the case of such a complex system as dehydrothioparatoluidine. The carbylamine derivative described in this paper, for instance, was only obtained after several hours' refluxing of the 4′ amino 1 phenyl 5 methyl benzothiazole with a large excess of both chloroform and alcoholic potash. Refluxing the above mixture steadily for six hours caused the production of a new substance, distinguished from the original base (1) by its partial insolubility in the alcohol and chloroform, and by the exhibition of different physical properties, such as colour, crystalline form, etc. This substance, which is assumed to be the compound (3) formed according to the usual condensation, possesses a faint, unpleasant odour reminiscent of phenyl isocyanide.

$$CH_3C_6H_3 <^{S}_{N}> C\ C_6H_4NC$$

(3)

$$S : C : [NHC_6H_4C <^{S}_{N}> C_6H_3CH_3]_2$$

(4)

Similarly it is to be expected that dehydrothioparatoluidine, when acted upon by carbon disulphide in the presence of a large quantity of alcoholic potash, would yield a thiourea of the substituted type (4), by the usual condensation and elimination of two hydrogen atoms from two molecules of the amino compound, as hydrogen sulphide.

By refluxing the necessary materials for several hours under the conditions described *in the experimental part of this* paper, a product of the expected type was obtained, which possessed a faint but very unpleasant odour after several purifications by means of alcohol. 4′ Amino 1 phenyl 5 methylbenzothiazole condenses with benzaldehyde in the presence of alcohol under suitable conditions to give the benzal compound (5) in 90 per cent. yield and in a high state of purity. In fact, it has been suggested that this benzal derivative might form a method of purification of the amino compound. In view of this, we should expect that dehydrothioparatoluidine would condense under suitable conditions with acetaldehyde to form the derivative (6) containing two thiazole rings. On performing the experiment under the conditions described hereunder, a product was obtained which is believed to be (6).

$$CH_3C_6H_3 <^{S}_{N}> C\ C_6H_4\ NHCH\ C_6H_5$$

(5)

$$>\left[C : [NH\,C_6H_4C \lessgtr^{S}_{N} > C_6H_3CH_3]_2\right]$$

(6)

In a similar manner, it would be expected that dehydrothioparatoluidine would condense with formaldehyde under suitable conditions to give the derivative (7), which likewise should contain two thiazole rings. On carrying out the experiment a derivative was obtained which is believed to be (7). There is, however, considerable experimental difficulty involved in these last two reactions. The condensation does not proceed with the smoothness of that in the case of benzaldehyde; a much longer refluxing is necessary. There is considerable difficulty in obtaining any kind of clean crystallisation, and the bulk of the product displays in a worse degree than usual, even in these compounds, the tendency to tar up into a brown resinous substance of a plastic nature with which nothing can be done as regards purification or anything else.

$$H_2C : [NH\,C_6H_4\,C \lessgtr^{S}_{N} > C_6H_3CH_3]_2$$

(7)

Experimental.

4′ Amino 1 phenyl 5 methylbenzothiazole.—This was obtained and worked up by the author's method (*Trans. Soc. Chem. Ind.*), that is to say, by sulphur fusion under the conditions described, of paratoluidine for four hours, the extraction of the melt with 30 per cent. sulphuric acid, followed by half neutralisation with caustic soda, followed by steam distillation if necessary, and subsequent successive crystallisations from boiling ethyl alcohol. The isocyanide of 4′ amino 1 phenyl 5 methylbenzothiazole: Pure dehydrothiotoluidine, an excess of alcohol, and a small piece of potash are placed in a 500 cc. flask fitted with a reflux condenser, and heated on a water bath. To the boiling solution, excess chloroform for the normal reaction is added, and the resulting mixture heated for four hours. The addition of chloroform produces a bright yellow substance, which floats on the surface of the liquid in the flask. The solution is filtered and the crystals washed with alcohol on the filter paper. These, when dry, are feathery in form, and of a grey yellow colour, and possess a faint unpleasant

The substituted thio urea: 0.5 gm. of dehydrothiotoluidine was dissolved in alcohol, and excess of carbon disulphide and a small piece of solid caustic potash added, and the resulting mixture refluxed on a sand bath. Unfortunately, the reaction proceeds too far with the production of tar. The experiment was repeated, using a water bath and an efficient water condenser. After an hour's refluxing, the excess of solvent was distilled off, and the solution allowed to cool. Grey yellow flocks of microscopic crystals separated in clusters. The quantity of these, however, was too small for investigation. The experiment was repeated on a rather larger scale, and the crystals filtered off, it was thought, to remove any traces of unchanged base by washing with dilute hydrochloric acid. This, however, dissolved the crystals with the effervescence of a foul smelling gas. The probable decomposition would appear to be

$$[CH_3C_6H_3 \lessgtr^{S}_{N} > C\,C_6H_4NH]_2\,CS + HCl$$

$$CH_3C_6H_3 \lessgtr^{S}_{N} > C\,C_6H_4\,NCS +$$

$$C_{12}H_{14}N_2S.HCl.$$

The experiment was again repeated, and the crystals freed from unchanged base by washing with alcohol.

Condensation with acetaldehyde: To a saturated solution of the dehydrothiotoluidine in alcohol, a slight excess of acetaldehyde was added, and the resulting solution refluxed for a short time (30 minutes), the resulting solution filtered from any residue into a distilling flask, and the bulk of alcohol distilled off from a condenser at a temperature of 30° C. This allows any aldehyde to escape, and leaves the solvent fairly pure for a subsequent crystallisation. The solution in the distilling flask is then allowed to crystallise, and the condensation product separates as brown yellow coloured crystals.

Condensation with formaldehyde: The above experiment was repeated, using formaldehyde in the place of acetaldehyde. The results were much poorer as regards yield, and the tendency to tar up was exhibited in a greater degree.

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A NOTE ON THE IMPORTANCE OF THE STUDY OF THE CRYSTAL STRUCTURE AND PROPERTIES OF METALS AT LOW TEMPERATURES.

By Cosmo Johns.

It is well known that, in a general way, the properties of the elements are periodic functions of their atomic weight or, as would be stated more correctly now, of their atomic number. Among others, Roberts-Austen,[1] Richards,[2] Edwards,[3] Haughton and Ford,[4] have discussed this periodicity with reference to the metals, but all these attempts have disclosed imperfections hich can be attributed either to inaccuracies in the data available or to some error in the method adopted for handling them. From time to time it has been pointed out[5] that no true comparison can be made unless the data used have been measured at strictly comparable temperatures. These comparable temperatures can only be known when the crsytal structure and significant properties of the metals have been determined over the widest possible range of temperature. Such comparable temperatures will, in all probability, be themselves a periodic function of the atomic number, and should therefore stand in some definite relation to the absolute melting point. It is obvious that to take data relating to properties which are known to vary with temperature, and to use those which have been measured at some temperature level selected for convenience only is to invite confusion, which can only serve to obscure, if not to hide, the relationship which is being investigated.

To mention but a few metals we find, if we examine them at room temperature, that mercury is liquid, lead so plastic that it is self-annealing after severe straining; aluminium displays a marked tendency in the same direction. Copper exhibits marked ductility after quenching from a moderately high temperature. Iron, when modified by the presence of carbon, loses ductility and acquires greater tenacity when quenched from above a certain critical temperature; when the iron is alloyed with 25 per cent. nickel or 12 per cent. manganese it ceases to behave like carbon steel on quenching, but becomes analogous to copper. This is known now to be due to the lowering of the inversion point by the addition of the alloy metal. Recently it has been demonstrated that iron above the critical range of temperature has a centre face cubic lattice, while below that range it crystallises in the centre body cubic lattice. Copper, manganese steel, and 25 per cent. nickel steel all have the centre face cubic lattice as the feature of their crystal structure at enriched air in metallurgical operations. If this cycle cannot be made to operate on lines sufficiently economical, then it would appear that the production of cold will not be so attractive as it appeared to be, and that the discarded barium oxide process might be re-investigated. Its old fault that it did not give pure oxygen may prove to be one of its virtues. The working temperature at which, with varying pressure, it absorbs or evolves oxygen is fortunately within the range of the now available impermeable alloys which resist oxidation. The temperature required can be supplied by the sensible or potential heat of the waste gases in many metallurgical processes. If refrigeration as a method of giving oxygen enriched air fails us, then barium oxide or some substance with similar properties require careful investigation, for mankind, in its metallurgical work, will not always be content to be controlled by the atmosphere nature provides.

(From "Transactions of the Faraday Society," December, 1922.)

[1] *Proc. Royal Society*, 1891, Vol. XLIX., pp. 347-356.

[2] *Faraday Lecture*, 1911, *Chemical Socty.*

[3] *Jour. Inst. Metals*, 1918, No. 2, pp. 86-88.

[4] *Trans. Faraday Society*, 1922, Vol. XVIII., Part I., pp. 112-118.

[5] *Professor Porter, Trans. Faraday Socty.*, 1922, Vol. XVIII., Part I., p. 118.

PLACER MINES OF CARIBOO, BRITISH COLUMBIA, CANADA.

The High Commissioner for Canada has received from the Dominion Department of Mines at Ottawa the following article, prepared by Mr. W. A. Johnston, of the Canadian Geological Survey:—

Placer gold mining in Cariboo, British Columbia, Canada, has been carried on almost continuously since the discovery of the field in 1860, and while the main production, amounting to several million dollars, was during the first few years after the

discovery, the output in 1922 was 192,300 dollars, which amount, however, was the largest annual output for a number of years. The chief reason why these placers have had an exceptionally long life is that that gold-bearing gravels are for the most part deeply buried beneath glacial drift in the bottoms of old stream channels; they are, therefore, not easily found by the prospector, and are frequently difficult to work because of the flow of underground water, which has to be controlled by pumping if drift mining is attempted. In recent years hydraulicing has been the chief method of mining, but has been more or less restricted because of the small supply of water in dry seasons. Only a few actual new discoveries of rich gold-bearing channels have been made since the early days of mining. One of the most notable of these is the Cedar Creek area, discovered in the autumn of 1921. The Cedar Creek Mining Company held the chief properties, and produced in 1922 and the early part of 1923, about 150,000 dollars in gold. Work was then stopped, because the method of mining proved too expensive. No adequate supply of water was available, and sluicing was carried on by pumping the water up from a reservoir. The property was reopened in October under a new management, but the problem of water supply has apparently not been satisfactorily solved.

One of the chief points of interest in the Cariboo district at the present time is the possibility of gold dredging. Drilling to test possible dredging ground was carried on a number of years ago, and a few areas of good dredging ground were proved, which, however, were not considered by dredging companies to be sufficiently extensive to warrant the installation of an expensive type of dredge such as would be required. Further drilling was carried on during the past summer, and is being careied on by an English company, in the hope of extending the known dredging ground, with so far not discouraging results.

The Barkerville area in the Cariboo district was examined by the Geological Survey of Canada in 1922 and 1923, and a report describing the placers and accompanied by a general geological and topographic map and maps of the several gold-bearing creeks will be issued in 1924.

A BRIEF FOR HIGHER ARSENIC.

The Possibilities of a World-Wide Famine Critically Considered.

By Howard W. Ambruster.

Controversy rages regarding the position of white arsenic in the American market. More or less violent fluctuations in the selling price of arsenic have always occurred both in normal times and under war conditions, and these are pointed to as evidence of a controlled market despite the fact that the supply is, and always will be irregular. The consumption also is not only variable from year to year, but is highly seasonal, as at least 80 per cent. of the arsenic consumed in the United States is used in plants which operate only three to eight months out of twelve.

An unbiased consideration of all the many factors which affect and control the arsenic market in this country indicates that there is an arsenic shortage at the present time and in prospect, and that this shortage is more or less world-wide. It has been brought about by three factors, namely: the smelters all over the world where crude arsenic is produced as a by-product, have been shut down altogether or running only part time for many months; there is an increasingly smaller percentage of arsenic in the ores now being treated in the American smelters; and the normal and the abnormal increases in the use of arsenic for agricultural spray manufacture are in excess of any increase in the world's supply which is in sight at anything like the present market prices. Either the consumption of arsenic for arsenical spray and other requirements must remain at approximately its present stage, thereby limiting development along these lines, or else the supply must be stimulated by a much higher market level which will encourage production of arsenic from direct sources to supplement the present by-product supply, the total of which has no relation whatever to the demand.

Sources of Arsenic.

The fact that arsenic is produced altogether as a by-product in smelters where precious and semi-precious metals are the direct and basic products is not generally appreciated by those who consider the situation from a commercial standpoint. In comparatively recent years this crude arsenic by-product was regarded as a costl

nuisance by metallurgists, and the great development of the use of arsenical insecticides in recent years would probably have been impossible if the smelters had not been compelled by legislation to make extensive plant installations to control the fumes and dust from their furnaces. Not so many years ago one of the important smelting companies actually considered the advisability of dumping the crude arsenic nto abandoned mine workings or pits dug 'or that special purpose.

It is evident, therefore, that the existing supply of refined arsenic from this source ıas no relation whatsoever to the demand, ut is based on the percentage of crude arsenic in the ores available from a mining nd metallurgical standpoint.

The arsenopyrite ores, containing an appreciable content of the more valuable netals in addition to iron, are probably the reatest sources of crude arsenic in the Jnited States and Mexico, and the cobalt nd nickel ores of Ontario largely comprise he balance of the supply on the North merican continent. In recent years a onsiderable amount of arsenic has also een recovered from accumulations of peiss at the older smelters, which has been etreated by modern methods for its preious metal content, but these stocks are iminishing rapidly, and there are also subtantial reasons to believe that the ores vailable for future smelting will not conain as high a percentage of arsenic as have ıose mined in the past. It should be nderstood that although arsenic is found ombined with over one hundred different ıineral products, it is only recovered when resent in appreciable quantities in cerain smelting operations.

DIRECT PRODUCTION UNSUCCESSFUL.

The direct production of arsenic has been ttempted a number of times in this country, but unless and until the selling price hall increase to, and remain permanently t, several times its present level, it is exremely unlikely that any such productions 'ill be commercially successful. Most of ıese projects have been based on the refing of mispickel, or arsenopyrite, containg no other element of value than iron, of hich there are deposits scattered all over ıe American continent. It is, of course, asily possible from a technical standpoint produce 99 per cent. arsenic from misickel, but the plant installation and the rocess are both costly, and, in face of the violent fluctuations of market price and by-product competition, little real progress in this branch of the industry has ever been made. The cost of production of white arsenic in the by-product plants is largely a matter of bookkeeping in that the cost of the crude arsenic up until the time it is collected from the smelter flues is, strictly speaking, an essential step in the smelting operation.

In the manufacture of arsenical sprays, by far the largest single item is lead arsenate, the present production amounting to a considerably larger total than all the others put together.

INCREASE IN USE OF CALCIUM ARSENATE.

The demand for Paris green and other arsenites, however, is decreasing with the wider dissemination of technical advice to the farmer, but the use of calcium arsenate promises to increase with great rapidity. The remarkable development of the market for this latter product has been greatly retarded for the time being by over production in the year 1920 and by the financial troubles of the South in 1921, which prevented extended use of calcium arsenate and also caused so large a quantity to be carried over. However, the prospects this year point to an extremely heavy infestation of the cotton fields by the boll weevil, and unless some more efficient method of control is developed the demand for calcium arsenate in the South is bound to increase tremendously in the next few years. How this demand shall be met by the available arsenic supply is the question which is dsturbing entomologists and others directly interested in the problem.

MARKET HISTORY.

The market price of white arsenic has fluctuated in the last fifteen years between one and one-half cents and twenty cents per pound, the low level having been touched in the pre-war period and the high mark at different times within the last few years. The wide fluctuations were, of course, partially due to war conditions, but these conditions were intensified by the various irregular factors, which always have and always will affect this product.

During the war the government finally stepped in and fixed the selling price by the producers at 9c. per pound, allocating the available tonnage to the various industries according to their importance from a

"win the war" standpoint. Since then the extreme demand was reached in 1920, when the open marget price stayed around 15c. for several months for immediately delivery of carload quantities. With the sudden decline of prices for all raw materials and finished products in the latter part of 1920, arsenic went down swiftly with the rest, and some contracts were made between five and six cents per pound in the last quarter of 1921. The price reacted to seven and one-half cents in the early part of this year, when the insecticide plants got into operation, and, while the peak of the demand has probably been passed for this season, the market is now in a very erratic state, with little real tonnage available for spot demand. There is also the prospect of another flurry when the production of calcium arsenate shall reach its maximum for this season in May and June.

Market Prospects.

In face of the actual shortage of arsenic stocks and current production the world over, the only reason why the market in the United States has not reacted more violently than it did this season is due to the act that many manufacturers carried over from last season large stocks of Paris green and lead and calcium arsenates, and the current demand has been eased because the *spray production has been divided this year.* the manufacture of calcium arsenate for the South having been postponed until the latest possible date and not overlapping, as it must in a normal year, the production of other arsenical spray materials. In addition to the increased demand in sight for the future, the selling price in the United States will be stiffened by the passage of the tariff now under consideration. Arsenic is at present on the free list, but the domestic producers have urged a relatively heavy specific duty, and the bill under consideration provides for a tariff of 25 per cent. *ad valorem.* However, as the ultimate consumer of the bulk of arsenic is the farmer, the tariff makers are hardly likely to go to extremes in protecting the American producer against the imported arsenic, as it is evident that the domestic supply is woefully less than the actual consumption. The smelters can hardly qualify as an infant industry in the eyes of the "Agricultural Bloc" at Washington. Taking the figure for 1920 as a basis of estimate, the consumption of arsenic in this country may be conservatively stated to approximate 16,000 tons per year, of which about 12,000 tons are of domestic production and the balance imported from Canada, Mexico, Germany, Japan and Belgium.

It is unlikely that there will be any appreciable increase in the total American production, or in the by-product production abroad. The reverse is more probable as far as the domestic smelters are concerned, on account of the ore situation and diminishing stocks of smelter dumps containing an appreciable percentage of arsenic. It is also unlikely that a larger tonnage of imported arsenic will find its way to the American market at present price levels, the market for arsenical products being world wide and the use of spray materials increasing in all agricultural countries, though in none so rapidly as in the United States.

To sum up the market situation for both the arsenic producer and consumer, it might be said that it represents an unending chain of controlling but conflicting elements. The producer has to run his smelter all the year round in normal times, but his arsenic production varies according to the ores he is treating, and he cannot have a uniform selling price in any event, because he cannot always ship as he produces. The primary consumer, the spray manufacturer, has an intermittent and irregular market for his products on the one hand, and a fluctuating raw material on the other, and therefore he cannot run his plant all the year round unless he speculates first on the cost of his principal raw material, and secondly on the market price and demand for his finished products. The ultimate consumer, the farmer, will not buy insecticides, as a rule, until the bugs actually appear, or at least until the season approaches close enough for him to forecast his needs. It is not to be wondered at that the arsenic market is a subject of conjecture and controversy, and it will undoubtedly continue so indefinitely.

(Reprinted from "Drug and Chemical Markets.")

GENERAL NOTES.

GERMANY'S POTASH INDUSTRY.

Mr. J. W. F. Thelwall, Commercial Secretary at Berlin, has given the Department of Overseas Trade the following statement

on the potash industry, which was made at a meeting of the German Potash Syndicate on December 18.

"While June of this year was the best sales month ever recorded by the industry, and orders of German agriculture were still satisfactory also in July, a bad stagnation in inland sales set in in September. This was at first attributed to the precipitate tax legislation and to the method of collection, and later to the currency chaos. Agriculture refused, not unjustly, to sell their products against paper marks, and the stable money which was promised, in the first place, to agriculture for the delivery of cereals, was not forthcoming. The issue of the Renten-Mark and the discount in kind which the Potash Syndicate granted during November, called forth a temporary revival of business, which, however, again came to a standstill immediately the provisions of the new property tax law became known. It is unfortunately the case that small and medium-sized agricultural undertakings, which cultivate more than 75 per cent. of the soil in Germany, have almost ceased to apply artificial fertilisers to their land, and that substantial restrictions in this respect have also been effected by large landowners. As a result, it is to be feared that the taxes will involve a great decline in production. The critical conditions on the market during the last five months have compelled the potash industry to drop shifts everywhere, and to dismiss employees. As a result of the decline in sales and of the consequent necessity of restricting operations, the costs of production have increased. No improvement can be anticipated without a substantial increase of production, which, again, is only possible if pre-war working hours are reintroduced. Further, it is feared that the spring trade also will be affected by the position of agriculture, the products of which at present fetch considerably less than the pre-war prices.

Foreign trade was satisfactory, and the percentage of foreign sales to inland sales showed an important rise in 1923.

The taking over of new works and the raising of the original capital has been postponed.

REDUCTION OF NITROGEN PRICES IN GERMANY.

Corresponding with the approximation of the gold mark to the foreign gold value, prices have fallen in many branches of industry. The consequent effect on costs of production has enabled the Nitrogen Syndicate to make a considerable reduction in prices; *e.g.*, sulphate of ammonia has been reduced from 1.40 to 1.15 gold marks per kilogram nitrogen.

The following is a list of the new prices which are applicable as from December 20:

	Gold M.
Sulphate of ammonia	1.15 per kg. N.
Sulphate of ammonia dried and ground	1.17 ,, ,,
Hydrochloride of ammonia	1.15 ,, ,,
Leuna saltpetre	1.15 ,, ,,
Potassium Nitrate of Ammonia	1.15 ,, ,,
Nitrogen of Lime	1.10 ,, ,,

The price now in force for nitrogen is about 13 per cent. below the pre-war price, and about 30 per cent. below that for Chili saltpetre.

DYESTUFFS ADVISORY LICENSING COMMITTEE.

The Board of Trade announce that they have appointed, as representatives of users of dyestuffs, Mr. A. Wadsworth, of Messrs. M. Oldroyd & Sons, Ltd., Dewsbury, and Mr. H. Sutcliffe Smith, Chairman of the Colour Users' Association, to be members of the Dyestuffs Advisory Licensing Committee set up under Section 2 (3) of the Dyestuffs (Import Regulation) Act, 1920, in the places of Mr. H. B. Shackleton and Mr. George Douglas respectively, resigned.

DYESTUFFS (IMPORT REGULATION) ACT, 1920.

Applications for Licences in December, 1923.

The following statement relating to applications for licences under the Dyestuffs (Import Regulation) Act, 1920, made during December, has been furnished to the Board of Trade by the Dyestuffs Advisory Licensing Committee.

The total number of applications received during the month was 460, of which 367 were from merchants or importers. To these should be added 28 cases outstanding on December 1, making a total for the month of 488. These were dealt with as follows:—

Granted—381 (of which 351 were dealt with within 7 days of receipt).

Referred to British makers of similar products—71 (of which 57 were dealt with within 7 days of receipt).

Referred to Reparation supplies available—19 (all dealt with within two days of receipt).

Outstanding on December 31, 1923—17.

Of the total of 488 applications received, 427, or 87 per cent., were dealt with within 7 days of receipt.

PROCEEDINGS AND NOTICES OF SOCIETIES.

THE ROYAL SOCIETY.

THURSDAY, JANUARY 17.

Papers read:—

A. MALLOCK, F.R.S., *Summary of the Results obtained from Experiments made during the years* 1918 *and* 1923 *of the Effects of Temperature on the Properties of Metals.*

M. BROTHERTON, *Experiments on the Emission of Electrons under the Influence of Chemical Action.* Communicated by Prof. O. W. Richardson, F.R.S.

M. D. HART, *On the Degradation of Acoustical Energy.* Communicated by Prof. A. N. Whitehead, F.R.S.

Papers read in title only:—

F. W. ASTON, F.R.S., *On the Velocity of the Positive Ions in the Crookes Dark Space.*

PROF. W. L. BRAGG, F.R.S., *The Structure of Aragonite.*

PROF. G. H. HARDY, F.R.S., and E. LANDAU, *The Lattice Points of a Circle.*

D. BRUNT, *The Dynamics of Cyclones and anti-Cyclones regarded as Atmospheric Vortices.* Communicated by Sir Napier Shaw, F.R.S.

C. D. ELLIS, PH.D., and H. W. B. SKINNER, *The Absolute Energies of the Groups in Magnetic β-Ray Spectra.* Communicated by Prof. Sir Ernest Rutherford, F.R.S.

C. D. ELLIS, PH.D., and H. W. B. SKINNER, *A Reinvestigation of the β-Ray Spectrum of Radium B and Radium C.* Communicated by Prof. Sir Ernest Rutherford, F.R.S.

C. D. ELLIS, PH.D., and H. W. B. SKINNER, *The Interpretation of β-Ray Spectra.* Communicated by Prof. Sir Ernest Rutherford.

H. D. SMYTH, *Further Studies in Ionisation: Hydrogen and Oxygen.* Communicated by Prof. Sir Ernest Rutherford, F.R.S.

L. F. BATES and J. S. ROGERS, *Particles of Long Range emitted by the Active Deposits of Radium, Thorium and Actinium.* Communicated by Prof. Sir Ernest Rutherford, F.R.S.

G. M. SHRUM, *The Doublet Separation of the Balmer Lines.* Communicated by Prof. J. C. McLennan, F.R.S.

SOCIETY OF GLASS TECHNOLOGY.

A meeting of the Society was held on January 16. The following papers were read and discussed:—

Further Contributions to the Study of the Effect of Alumina in Glass, by VIOLET DIMBLEBY, B.Sc., S. ENGLISH, M.Sc., F. W. HODKIN, B.Sc., and PROF. W. E. S. TURNER, D.Sc.

The Production of Colourless Glass in Tank Furnaces, with Special Reference to the Use of Selenium, Part III.: The Influence of Light and Temperature on the Change of Colour, by A. COUSEN, B.Sc., and PROF. W. E. S. TURNER, D.Sc.

There were also discussions on the following:—

Specifications for Glass, based on the paper read at the London meeting on Dec. 12, 1923, by PROF. W. E. S. TURNER, D.Sc.

The Production of Colourless Glass in Tank Furnaces, with Special Reference to the Use of Selenium, Part II.

THE ROYAL INSTITUTION OF GREAT BRITAIN.

The Friday evening discourse on January 18 (at 9 o'clock) will be delivered by Prof. H. E. Armstrong, LL.D., F.R.S., on *The Scientific Work of Prof. Sir James Dewar, LL.D., D.Sc., F.R.S.*

On Tuesday, January 15, PROF. W. L. DIXON, M.D., F.R.S., read a paper on *Drug Addictions.*

On Thursday, January 17, W. SICKERT read a paper on *Straws from Cumberland Market.* (Lecture I.).

THE CHEMICAL SOCIETY.

At the Ordinary Scientific Meeting on Thursday, January 17, the following papers were read:—

A suggested Explanation of the allotropic Transformations of Iron, by R. H. ATKINSON.

The Activity of Water in Aqueous Hydrochloric Acid, by H. J. E. DOBSON and I. MASSON.

The Freezing of Inorganic Hydrogels, by J. R. I. HEPBURN.

THE OPTICAL SOCIETY.

A meeting of the Society was held on Thursday, January 10. The following papers were presented and discussed:—

The Relation between Aperture, Axial Thickness, and Form for a Single Lens, by T. SMITH, M.A., F.INST.P.

The determination of Aberrations as expressed in Geometrical Optics from the Indications of the Hilger Interferometer, by J. W. PERRY.

Replicas of the two Galileo telescopes at Florence were exhibited by the kind permission of Col. H. G. Lyons, F.R.S., Director of the Science Museum, and described by Mr. David Baxandall, A.R.C.S.

The Annual General Meeting for the presentation of accounts and election of officers will be held on February 14.

THE MINERALOGICAL SOCIETY.

At the meeting on January 15 the following papers yere read:—

A. F. HALLIMOND, *The Chemical Classification of the Mica Group*.

DR. A. BRAMMALL and DR. H. F. HARWOOD, *Gold and Silver as Accessory Minerals in the Dartmoor Granite*.

A. RUSSELL, *Topaz from Cornwall, with an Account of the Localities, Old and New, at which it is found*.

H. C. G. VINCENT, *Chemical Analyses of Granite from Dufton, Westmorland, and of Mica from Burma*.

THE INSTITUTION OF ELECTRICAL ENGINEERS.

At the meeting on January 17, a paper entitled *Electric Passenger Lifts* was read by H. MARRYAT, member.

THE INSTITUTION OF PETROLEUM TECHNOLOGISTS.

Papers read at the meeting at the Royal Society of Arts, on January 8:—

The Crude Oil of Sarawak, by JAMES KEWLEY, M.A., F.I.C., F.C.S.

Sarawak oil is of naphthenic type, but the recent appearance of a paraffin base oil at about 1,950 feet indicates that wax-bearing oils may be characteristic of the lower levels.

The crude is a mobile liquid, reddish brown in colour, and of agreeable odour. A sample of the mixed crude oil gave the following data:—

Specific gravity, 0.902; refractive index at 15° C., 1.5075; and iodine value, 12.8.

It is deficient in fractions of low boiling point and from paraffin wax, and remarkably so from asphaltenes. It has very low viscosity, low sulphur content, and yields products which are easily refined.

Elementary analysis of the crude oil shows the C/H ratio to be high. No attempt has yet been made to isolate individual hydrocarbons, or even to get any evidence as to the actual nature of the hydrocarbons which make up the bulk of the crude. The practical absence of paraffins, except in the most volatile fractions, is noticeable. Negative bromine and iodine values indicate the absence of unsaturated hydrocarbons, at any rate in the fractions of relatively low boiling points.

Of the chemical composition of the higher fractions nothing is definitely known.

The Crude Oil of Maidan-i-Naftun, by A. E. DUNSTAN, D.Sc., F.I.C., F.C.S.

A brief introduction on the working and geology was given.

Gas accompanies the crude oil taken from the producing wells at Maidan-i-Naftun, most coming to the surface dissolved in the oil or in the form of an emulsion, and is only separated from it on reduction of the pressure.

The difficulties attendant on handling such volumes of gas are intensified by the presence of sulphuretted hydrogen which render the gas poisonous.

The low pressure gas contains 10 per cent. sulphuretted hydrogen and carbon dioxide, carbon monoxide, hydrogen, argon, helium, etc., olefines, and 89 per cent. paraffins.

From its vapour density and calorific

value the low pressure gas contains appreciable quantities of easily liquefiable hydrocarbons. After passing high-pressure well-head gas, which is already almost free from liquefiable constituents, through a freezing mixture of acetone and solid carbon dioxide, the original vapour density of 11.8 was reduced to 10.5. It appears, therefore, that the remaining gaseous hydrocarbons are preponderatingly methane.

The gas employed at the fields, and at the main pumping station, is desulphurised by treatment with milk of lime, but a continuous process based on the precipitation of sulphur from hydrogen sulphide by the action of sulphur dioxide solution has given good results.

It is intended to utilise the sulphur content, strip the gasoline as far as is practicable, and use the residual gas for power.

Experiments have been carried out on the thermal decomposition of the gas. It is well known, of course, that the burning of natural gas against a metallic surface under conditions of incomplete combustion yields carbon black, a material for which there is a fair demand, but the process is scientifically uneconomical, and therefore further work has been carried out on the complete pyrolysis of the gas.

Persian crude oil is a brown mobile liquid with a green fluorescence of mean specific gravity 0.837.

It is an oleosol, in which small amounts of asphaltic compounds and amorphous waxes are dispersed in a hydrocarbon continuous phase. This constitution is clearly shown by ultramicroscopic observation; the asphalts are readily floculated by a trace of sulphuric acid, while the soft waxes are slowly deposited when the oil is allowed to stand.

It possesses a notable proportion of aromatic hydrocarbons. The benzine fraction, for example, contains 10 per cent. of benzene, toluene and xylene.

At 120° C. certain components of the crude oil decompose and liberate water, sulphur dioxide, and hydrogen sulphide, which interact to form colloidal sulphur.

If the oil is distilled in steam, and at low temperature, the sulphur content of the distillates is considerably lessened, so that much of the thio-derivatives normally present in the benzine and kerosene are derived from the thermal decomposition of sulphur-containing compounds of high molecular weight.

A typical once-run distillate had Sp. Gr. 0.752 at 60° F.

It is refined before cutting into gasolene and kerosene, or redistilled before treatment. The removal of the sulphur compounds has presented some difficulty, but is conveniently accomplished by means of the hypochlorite process.

Free hypochlorous acid or chlorine water may be employed in this oxidation, but this treatment causes some chlorination, particularly of the heavier components. If the product, after treatment, is distilled, a perfectly good benzene distillate is obtained, whilst the chlorinated bodies in the residue are easily removed by adsorption on bauxite.

The distillate is washed with a 10 per cent. solution of caustic soda. The preliminary alkali wash removes hydrogen sulphide and sulphur dioxide, and acidic organic sulphur compounds. Efforts are being made to isolate definite sulphur compounds from the spent soda, and this work has already resulted in the separation of a body giving a mercury compound and a crystalline silver derivative.

The oil is then treated with sodium or calcium hypochlorite containing free alkali equivalent to 0.5 gms. of caustic soda per litre. The duration of the second wash may be curtailed by the use of a "destabiliser," which reduces the concentration of hydroxyl ions. The most effective "destabiliser" is carbon dioxide.

The once-run distillate is now ready to be distilled into gasoline and kerosene.

The gasoline which is distilled from the hypochlorite-treated once-run distillate requires no further refining. It amounts to rather more than 20 per cent. on the crude oil.

The advantages of the hypochlorite process as compared with the use of sulphuric acid are:—

There is less loss on refining, for no aromatic hydrocarbons are lost in the form of sulphonic acids.

No acid sludge is formed, and no acid recovery plant required.

The treatment can be carried out in ordinary steel vessels, since corrosion of washers, piping, etc., is much less than is the case when acid is employed. Lead-lined apparatus is not required.

The sum total of operations is easier to carry out than the acid refining process with the acid recovery, etc., incident to the latter.

The process is applicable to the light distillates from all types of crude petroleum which contain sulphur.

White spirit and kerosene are also obtained from the once-run distillate.

Persian residues can be cracked successfully for the lowering of viscosity or the production of light spirit.

A mild form of cracking, whereby the oil is subjected for a limited time to temperatures of approximately 400° C. and pressures of about 200 lb. per square inch, has successfully overcome the "gelling" phenomenon characteristic of the heavier Persian residue. This gelation occasionally causes some difficulty in the use of 50 per cent. or more concentrated residues as fuel oils in cold climates, owing to the considerable increase in the viscosity of the oil on standing.

NOTICES OF BOOKS.

The Chemical Elements, by F. H. Loring. Pp. VIII. + 171. London: Methuen & Co., Ltd., 36, Essex Street, Strand. 1923. Price 8s. 6d.

Mr. Loring's studies in the realms of Atomic Science are not unknown to readers of *The Chemical News*.

In the present volume he has developed certain themes in connection with the chemical elements that were not dealt with in his *Atomic Theories*, the first edition of which, it will be recalled, was the earliest comprehensive book on the subject.

It is apparent from this book that the author realises the importance of studying the phenomena exterior to definite entities as revealed in the behaviour of electrical bodies, magnetism, etc., which leads him to introduce the term "Space Physics." The phase of development in connection with the Chemical Elements is, no doubt, of far-reaching importance, and Mr. Loring writes in a highly suggestive way with regard to some matters which cannot, as yet, be reduced to a definitely crystallised state.

The first chapter on the Atomic Weights and Isotopes of the elements is particularly lucid, and is amplified by an appendix giving some comparatively recent experimental results in this field.

On page 14 the author shows the sectional development of the Periodic Table, from which a series of numbers are derived, based upon a paper published in this Journal as far back as 1912, which is reproduced without emendation in Chapter II.

This is of interest in connection with Mr. Loring's contributions, indicating that the Natural Groupings of the Elements and the Spectral Lines of Hydrogen are related. But the author has chosen as a key statement one of Prof. Eddington's indicating that one universal law may have the widest possible application. Mr. Loring's recent studies on the hydrogen atom and the planetary system amply justifies the use of this statement.

Another interesting feature of this volume is the development of the author's views on the missing elements in the Periodic Classification, following upon which is his Wedge System of representing the relationships between the elements.

Great stress is laid on the binding principle involved in the Bohr atom as well as in the Lewis-Langmuir atom.

From this the author passes to the Quantum Theory proper, and gives a mechanical model illustrating the peculiarity of Planck's Law in connection with the spectrum, making the matter very clear to the student.

The chapter on Energy is also of considerable interest, but one particularly commendable feature of the whole book is the introduction of summaries at the end of each chapter, recapitulating in a condensed form the matter so far traversed.

Thus, Chapter XII., on the *Electrical Nature of the Atom as revealed by Radio-activity and the Classification of the Radio Isotopes* (page 111), concludes with the following summary:—

"There is an accumulation of evidence that the atom is an electrical system. This system has been thoroughly studied in some respects, for in the case of the radio-active elements they emit positively-charged helium atoms and negative electrons in such a systematic manner that it has been possible to make a complete periodic classification of these elements. The electrical data and other data now known in connection with these elements have been brought together in an extensive set of tables issued by the International Committee on Atomic Weights, and these are reproduced in this chapter (Table VII.), with notes and explanatory statements. Making use of some of the tabulated information and of the general scheme of classification, a special form of periodic table has been prepared, which fits on to the main table shown on page 34. In the former table certain data are inserted, being based upon the idea

that the atomic numbers may be analysed in connection with another series of numbers already revealed in the above-mentioned main table. Another table is developed in order to show how these data can be provisionally arranged to give expression to the atom being stable or unstable, produced in quantity or not even produced at all; and this treatment is in general harmony with the ideas developed in Chapters III., IV., and V., viz., that the prolificness in production is dependent upon number. The latter part of this chapter may be designated a *study in numbers*, but this study is intended only to show the possibilities in this direction without offering a complete solution of this phase of the problem, *i.e.*, of stability, etc. Whatever may be said for or against the ideas advanced, there is a general agreement between experiment and theory, but the reader is here cautioned not to expect too much of " theory," as there is a good deal of unexplored ground in this part of the atomic field."

Chapter XIV., *Limitations in Theory*, is also worthy of mention.

It is to be hoped that in a second edition the author will be able to include much of the valuable matter given in the appendices in the general text.

The book has evidently been written with great care, and contains important information and many valuable suggestions, which are all presented in a clear way. It is altogether worthy of a place on the shelves of every scientific library.

J.G.F.D.

From Determinant to Tensor, by W. F. Sheppard, Sc.D., LL.M. 7½ ins. x 5 ins. Pp. 127. Oxford: The Clarendon Press. 1923. Price 8s. 6d. net.

Students of the theory of relativity will be very grateful to Dr. Sheppard for providing them with this very useful little manual. As the author points out in his preface, the tensor calculus " is, like the various kinds of vector calculus, a system of condensed notation which not only conduces to economy in the writing of symbols, but, what is more important, enables spatial and physical relationships to be grasped as a whole without having to be built up from a number of components which really represent views from different parts of space." In dealing with the problems of a four dimensional geometry, such as is encountered in the theory of relativity, such a calculus as this is quite essential; but the tensor calculus can be used for solving much simpler types of problems, and it is mainly with these that Dr. Sheppard's book is concerned. " The book," he says, " is not intended as an introduction to the mathematical theory of relativity," but, nevertheless, as I have said, students of relativity will be grateful to him for it, because the facility which they will gain in the use of the tensor calculus by studying these comparatively simple problems will render the task of using it, in dealing with the problems of relativity, so much the easier. The final chapter in the book, moreover, is concerned with the use of tensors in the theory of relativity. A mastery of determinants is a necessary preliminary to the study of the tensor calculus; but the presentation of the theory of determinants in many textbooks of Algebra is not usually very interesting, and Dr. Sheppard has done well, therefore, in devoting the first four of his chapters to a treatment of determinants, which treatment, it should be said, is by nc means lacking in originality of presentation.

H. S. Redgrove.

The Physical Chemistry of the Photographic Process.—A General Discussion held by The Faraday Society. Pp. 24(to 406. 1923. London: The Faraday Society, 10, Essex Street, Strand, W.C.2 12s. 6d. net.

The Faraday Society has issued as separate monograph the contributions t the discussion on the Physical Chemistr of the Photographic Process, which wa held in May last (see *The Chemical News* 1923, CXXVI., 346, 352, 359, 362, June and 8).

The monograph is divided into four se tions dealing with the physical chemistr of the Vehicle and the Emulsion; the R actions of the Plate during Exposure; D velopment; and Adsorption Reaction The most eminent physical and phot graphic chemists in the world have contr buted to the discussion.

To the chemist who is also a phot grapher, a perusal of this monogra creates or confirms the impression th even such a limited subject as the physic chemistry of photography has made su strides, and has been the field of so ma investigations, that it is difficult for anyo but a specialist to keep informed of t latest developments.

BOOKS RECEIVED.

The Theory of Relativity: Three Lectures for Chemists, by ERWIN FREUNDLICH, translated by HENRY L. BROSE, M.A. Pp. XII. + 98. 1924. Messrs. Methuen & Co., Ltd., 36, Essex Street, W.C.2. 5s. net.

PUBLICATION RECEIVED.

The Department of Overseas Trade has published, through His Majesty's Stationery Office, a *Report on the Economic and Financial Conditions in Venezuela* (September, 1923), by MR. T. J. MORRIS, H.B.M. Chargé d'Affaires, Caracas. Price 1s. (post free 1s. 0½d.).

Trade in Venezuela for the last twelve months has been comparatively good. The country has not been seriously affected by the war, and, with the return of more normal prices, there is no reason, unless untoward events occur, why its economic development should not continue on the lines of steady expansion and improvement.

The greater part of the population is engaged in cattle raising and agriculture. The principal agricultural products are coffee, cocoa, sugar, cotton, tobacco and maize. The forest regions produce balata, rubber, Tonka beans, and a vast variety of tropical forest products, as well as various kinds of valuable timber. Coal of fair quality is also found in the country, and on certain parts of the coast there are valuable pearl fisheries.

Manufacturing industries are on the increase. Among the articles manufactured at present are the ordinary kinds of cotton textiles, sole leather, common soap, candles, glass, cement, cigars and cigarettes.

Venezuela provides a market for the disposal of British goods to the value of about a million pounds annually.

The petroleum industry is attracting great attention. The total crude petroleum exploited in Venezuela by the Caribbean Petroleum Company, a company registered in America but allied with the Royal Dutch Shell interests, to Dec. 31, 1922, was 729,619 metric tons. The outlook of the industry is decidedly promising, and when transportation facilities have been improved a new impetus will no doubt be given to production.

The principal imports are textiles, machinery, crockery, drugs, chemicals, perfumery, automobiles, and foodstuffs.

Venezuela is a very good market for drugs and patent medicines of all kinds, especially those suitable for tropical diseases, but British firms are not adequately represented. The market at present is almost entirely held by the United States, Germany and France.

DEPARTMENT OF THE INTERIOR, UNITED STATES GEOLOGICAL SURVEY,

has issued the following Bulletins:—

Outline of Ground-Water Hydrology with Definitions, by OSCAR E. MEINZER. Pp. IV. + 71.

Surface Water Supply of the United States, 1921, by NATHAN C. GROVER. Pp. 111 + 39.

Silver, Copper, Lead and Zinc in the Central States in 1922, by J. P. DUNLOP and F. BEGEMAN. Pp. 138 + 168.

Tin in 1922, by BERTRAND LEROY JOHNSON. Pp. 169 + 172.

Clay in 1922, by JEFFERSON MIDDLETON. Pp. 73 + 80.

Talc and Soapstone in 1922, by EDWARD SAMPSON. Pp. 81 + 86.

Potash in 1922, by GEORGE ROGERS MANSFIELD. Pp. 88 + 107.

Phosphate Rock in 1922, by GEORGE ROGERS MANSFIELD. Pp. 109 + 132.

Gypsum in 1922, by K. W. COTTRELL. Pp. 133 + 139.

Coal in 1919, 1920, *and* 1921, by F. G. TRYON and SYDNEY A. HALE. Pp. 445 + 662.

CORRESPONDENCE.

SOAP-MAKING.

To the Editors of THE CHEMICAL NEWS.

SIRS,—I tried recently to convert a quantity of fat into soap, following a method given in a textbook on "Oils, Fats and Waxes." I do not understand the so-called "fitting" of the soap. The curdy mass of soap obtained by the final "salting out" obviously contains much less water than the soap sold in shops, and it certainly looks much drier. Is it meant that this curdy mass should have water added to it to bring it into the condition of finished soap? If so, how much? Would it be possible to give the necessary amount of water as a percentage by weight of the curdy mass of soap to be "fitted"? I presume that after the final salting out, and before "fitting," it would be necessary to draw

off the lower aqueous layer of salt solution and excess caustic soda. If that were done I cannot see how there can be a salt solution and no excess of soda beneath the soap ater it has settled for some days, as is suggested in the method I have followed. Neither does the author state whether the dark under-layer is rejected or retained in the finished article. He stated also that the finished "neat" soap, whilst *still warm*, is run into soap frames and allowed to cool therein. Yet, a few lines higher up he states that the mass has been settling in the soap pan for a few days. I fail to see how the soap paste could possibly be *still warm* after settling for a few days, and presume that before casting it is necessary to re-heat the soap. In my experiment I saponified 6½ pounds of fat with with a pound of caustic soda, and after "salting out," obtained a cake of curdy white soap on the surface of the liquid. The cake is not homogeneous, but contains little globules of soap which refuse to coalesce. What is the colouring matter used for yellow soap, and where is it possible to purchase fat and soda at wholesale prices? I should be glad if any of your readers could give me information on this matter.—Yours, &c.,

FREDERICK HIGHLEY.

Southsea, Hants.

[*Mr. Highley has enclosed a copy of the method he followed, which is certainly not clear. Two recent publications which deal* with soap-making are Lewkowitsch's *Chemical Technology of Oils, Fats and Waxes* (Macmillan), and Holde's *Examination of Oils and Saponifiable Fats and Waxes* (Chapman & Hall).—ED.]

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Latest Patent Applications.

32523—Soc. of Chemical Industry in Basle.—Manufacture of physiologically-active substances. Dec. 29.

32359—Grasselli, C. A. — Processes of making hydro-chloric acid and salt cake. Dec. 27.

32416—Clerc, C.—Treatment of zinc ores. Dec. 28.

Specifications Published this Week.

188634—Guggenheim Bros.—Methods and processes for the leaching of caliche and for the recovery of nitrate therefrom.

186900—Farbwerke Vorm. Meister, Lucius & Bruning.—Manufacture of methane.

201510—Soc. de Stearinerie et Savonnerie de Lyon.—Process of manufacturing cellulose esters.

195089—Aktieselskabet Hydropeat.—Manufacture of colloidal solutions of ferric oxide.

198645—Nydegger, Dr. O.—Processes of manufacturing sulphate of chromium.

208193—Stokes, J. S.—Synthetic resins and the process of making same.

206449—Standard Development Co.—Process of dehydrating alcohol.

206502—Leigh, R.—Hampers or crates for acid carboys and the like.

199007—Compagnie de Bethune.—Manufacture of sulphovinic acid from ethylene.

Abstract Published this Week.

206698—Dyes.—Badische Anilin-de-Soda-Fabrik. Ludwigshafen-on-Rhine, Germany.

Dibenzanthrone compounds.—Vat dyes are obtained by treating with an aldehyde, polymerised aldehyde, or acetal, the oxidation product of dibenzanthrone, or the reduction or condensation product therefrom, described in Specification 14408/12; the reaction may be effected in presence of sulphuric acid or indifferent solvents or diluents, with or without condensing-agents. According to examples, formaldehyde, trioxymethylene, or methylal, paraldehyde, and anthraquinone-2-aldehyde are employed; the products dye violet-blue and reddish-blue shades.

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THE CHEMICAL NEWS.

VOL. CXXVIII. No. 3328.

ARE THE NATURAL GROUPINGS OF THE ELEMENTS AND THE SPECTRAL LINES OF HYDROGEN RELATED?

PARTS X. AND XI.—(*Concluded*).

BY F. H. LORING.

In continuation of the subject,* as indicated by the above title, it is necessary to refer back to Part VII., since the writer has obtained a fairly complete set of more recent satellite distances, as given together in tabular form in Sir Robert S. Ball's "Popular Introduction to the Heavens" (1910), 3rd edition, page 10; and here below it is shown that the significant relations still exist, when using these newer figures; but it is, of course, understood from the outset that the ideal values, 48, 21, 13, 9, 7, were only bull's-eyes, so to speak, round which the respective values ranged, so that by taking averages the significance of the numbers was established. A still newer set of values from Heath's "Popular Astronomy," 1922, 3rd edition, is also given with better results.

Proceeding, therefore, along the lines already established, but first making use of Prof. Ball's values, with the exception of two newly-discovered satellites, the values for which are taken from recent literature and indicated by a dagger (†), the tabulations and averages are presented in the next column.

The dividing constant, in this case K′, was calculated from the values of Uranus exactly in the same manner indicated on page 387 of Part VII., and it of course applies throughout the tabulations on this page. The letters M′, K′, N′, are obviously the newer values based upon Ball's figures. M′ is miles, as before.

With regard to the satellites of Mars, the values given by the above astronomer are as follow, but against which are placed the miles calculated by the method of Part IX., page 17, of the current volume of *The Chemical News*:—

EARTH.

S.	M′. / K′.	N′.	B.
Moon ...	239,000/18,500	=12.92	13

NEPTUNE.

S.	M′. / K′.	N′.	B.
Nameless .	221,500/18,500	=11.97	13

URANUS.

S.	M′. / K′.	N′.	B.
Ariel	120,000/18,500	= 6.49	7
Umbriel ..	167,000	= 9.07	9
Titania ..	273,900	=14.75	13
Oberon ..	365,000	=19.73	21

JUPITER.

S.	M′. / K′.	N′.	B.
Nameless	112,500/18,500	= 6.08	7
—	—	—	9
Io	261,000	=14.10	13
Europa ..	415,000	=22.43	21
Ganymede	664,000	=35.89	
—	—	—	* 48
Callisto ...	1,167,000	=63.08	

* Average = 49.48.

SATURN.

S.	M′. / K′.	N′.		B.
Mimas ..	117,000/18,500	= 6.32	*	7
Enceladus	150,000	= 8.10		
Tethys ..	186,000	=10.05		9
Dione ...	238,000	=12.86		13
Rhea	332,000	=17.94		21
Titan	771,000	=41.67		
Themis† ..	892,000	=48.21	**	48
Hyperion .	934,000	=50.48		
Iapetus§ .	2,225,000	=120. See IX.		
Phœbe† ..	7,900,000	=427.‖ See IX.		

* Average = 7.21. ** Average = 48.78.
§ Sometimes spelt with a J.
‖ Calculated value 420.

MARS.

Phobos	5,850.	Calculated	6,451
Deimos	14,650.	Calculated	15,091

With regard to the averages by the method of Part VII. (*continued*), Vol. CXXVIII., 1924, page 6, the above values (corresponding to the numbers 7, 9, &c.), give the following results:—

(6.49 + 6.08 + 7.21)/3	=	6.59	7
(9.07 + 10.05)/2	=	9.56	9
(12.92 + 11.97 + 14.75 + 14.10 + 12.86)/5	=	13.32	13
(19.73 + 22.43 + 17.94)/3	=	20.03	21
(49.48 + 46.78)/2	=	48.13	48
Averages		19.52	19.60

*See "*The Chemical News*," 1923, *Vol. CXXVII.*, *pp.* 225, 257 (I.), 273 (II.), 290 (III.), 337 (IV.), 355 (V.), 369 (VI.), 386 (VII.); *Vol. CXXVIII.*, 1924, *pp.* 5 (VII., [illegible] 17 (IX.)

Making use now of the latest satellite distances, as recorded in Heath's "Popular Astronomy" (1922), 3rd edition (with no omissions therefrom), the following results are obtained, using, of course, the same methods in arriving at the constant K″, etc.

S.	M″. K″.	N″.	B.
	EARTH.		
Moon	238,840/18,346	13.01	13
	NEPTUNE.		
Nameless .	222,000/18,346	12.10	13
	URANUS.		
Ariel	118,300/18,346	6.44	7
Umbriel ..	166,500	9.07	9
Titania ...	270,600	14.74	13
Oberon ...	361,900	19.72	21
	JUPITER.		
Nameless ..	111,800/18,346	6.09	7
—	—	—	9
Io	260,000	14.07	13
Europa ...	413,900	22.56	21
Ganymede	660,400	35.99 }	* 48
—	—	— }	
Callisto ...	1,162,000	63.33	
Nameless ..	3,192,000	174.	**
Nameless ..	4,162,700	221	**

* Average = 49.66. ** Average = 197.5; see Part IX.

S.	M″. K″.	N″.	B.
	SATURN.		
Mimas	116,050/18,346	6.32 }	* 7
Enceladus .	148,930	8.11 }	
Tethys ...	184,100	10.03	9
Dione	236,250	12.88	13
Rhea	330,000	18.00	21
Titan	764,300	41.66 }	
Themis ...	912,500	49.74 }	** 48
Hyperion ..	925,700	50.45 }	
Iapetus ...	2,227,000	121.	
Phœbe ...	8,090,700	441.	

* Average = 7.21. ** Average = 47.28.

Commenting on the above values, there is one for Phœbe, 8,090,700 miles, which is greater than the corresponding recent value introduced in the previous tabulation, suggesting that the latter one may he too high.

Referring to the single satellite of the most distant planet, Neptune, it is probable that its true value is the same as that of the Moon, since Neptune's satellite is observationally so distant, its value cannot be known with the same accuracy as that of the Moon.

Referring to Jupiter, there may be an undiscovered satellite corresponding approximately to the value 9. Its mean distance from its primary in miles should be about 18,346 × 9.

Considering now the satellites of Mars, the constant, K″, requires in this case its reduction to $\frac{1}{4}$, viz:—18,346/4 = 4586.5. *Referring to Part IX., the Balmer numbers* 13 and 5.58 (for the next line after ε, *i.e.*, the ζ line of wave-length 3889.21) divided by 4, in correspondence with the Lyman series, involves numbers 3.250 and 1.395. From these values it is possible to calculate the mean distances of Mars' satellites from the centre of this planet, thus:—

3.250 × 4586.5 = 14,906. About 15,000.*
1.395 × 4586.5 = 6,398. About 6,000.*

* From Heath's book, *loc cit.*

Referring to the foregoing tabulation involving the more recent values taken from Heath's book, the following comparative averages are obtained:—

(6.44 + 6.09 + 7.21)/3	=	6.58	7
(9.07 + 10.03)/2	=	9.55	9
(13.01 + 12.10 + 14.74 + 14.07 + 12.88)/5	=	13.36	13
(19.72 + 22.56 + 18.00)/3	=	20.09	21
(49.66 + 47.28)/2	=	48.47	48
Averages		19.61	19.60

It is of interest to note that when the value is one which is most accurately observed, that of the Moon's distance from the Earth, it agrees most closely with the corresponding series figure established from the spectrum of hydrogen; but it is not suggested that where deviations occur the observed values are always proportionately inaccurate; for it is implied that the tendency of the planets and their satellites to fall into a perfectly regular series has been disturbed by events of which no knowledge is known. Moreover, where there are many satellites the perturbing influence is greater, as instanced in the figures for Saturn and Jupiter.

Corrections. — On page 17, issue of January 11, 1924, 8th line from the bottom of the page, "2.25" should read "1.25." On page 6, issue of January 4, 1924, 2nd column, 2nd line from top, "Mimas" should read "Umbriel," and on the next line, "Jupiter" should read "Uranus." On page 387, issue of December 21, 1923, under NOTES, "Lassell should read "discovered by Lassell."

PART XI.

Referring to several Parts of this series of papers, which have not been summarised, it is suggested—and endorsed by the Editors of *The Chemical News*—that, on this account and the fact that several additions and modifications in detail have been made in developing the subject, a general summary of the whole series of papers, including the last one published on the question of an element of zero atomic number, would be of interest.

Before making this general summary, a few notes will be appended here.

1.—The reader should particularly observe that the writer has taken his astronomical data as much as possible from one source of information each time, rather than making selections of values. It is obvious that by so doing, the personal equation is reduced to a minimum; and, moreover, in giving values at periods of 1889, 1910, 1922, the historical development in respect of the values used is shown. The argument is also greatly strengthened by showing that, as better values are obtained, greater accuracy of result follows, as instanced in the one for the Moon's distance showing exact agreement with the latest value based upon the dividing constant obtained by averaging the values for the satellites of Uranus, where comparatively little perturbation is to be expected when taken in the average manner indicated.

2.—In speaking of the "*entrant direction*," Part VI., Note 1, this term was used merely as representing the state, so to speak, of the body when considered as starting, for example, on its proper elliptical path round the nuclear sun, the sun being the centre of attraction or the centre of the gravitational field. Whether this *state* arises either from the body having been ejected from the sun, or separating out from some other previous form of the solar system or star; or whether it arises from the body being fired into the solar system from some remote engine of the heavens, makes no difference so far as the starting point is considered within the solar system proper, so that the orbit will properly intersect it. It is generally stated in astronomical books that the elliptical orbit in the case of comets arises often from the planets attracting the comet so as to change its course, which otherwise would continue to describe either a parabolic or hyperbolic curve, as the case may be.

3.—The general subject of these papers is of interest in connection with the theory of the formation of the planetary system, as so many phenomena seem to be analogously represented atomically. Perhaps the key to the universe is the atom—a statement which some years ago would be regarded as a poet's dream.

RECAPITULATION.

Starting with the 5 Balmer lines of hydrogen, α, β, γ, δ, ϵ, the writer shows that they were connected linearly with 5 whole numbers, 48, 21, 13, 9, 7, so that taking the wave-length in A units, these numbers could be closely calculated by the formula $(\lambda - 3540)/62.5 = \alpha, \beta, \gamma$, &c.

It was shown that the periodic table of the elements afforded a system of sectional groupings which involved these same numbers, 48, 21, &c., provided, as one special feature, an element of zero atomic number was stationed at the head of the inert-gas group, so as to make the total number 7. That such an element was quite possible was previously shown by the writer's development of his wedge periodic table, and afterwards strengthened by showing that hydrogen stood at the high end of a short two-part wedge, thus linking up this element electronically with lithium immediately below it, and at the same time paralleling it in terms of altitude with the halogen atoms which stand at the high ends of the other wedges which are longer and include the elements between them and the inert gases. The wedge table is thus developed in 3 dimensions of space, and all the chemical and physical (electron bindings) properties are in general harmony. There are flats which take elements of Group VIII., and those of the rare-earth series from Pr to Lu inclusive, giving numbers 9 and 13 respectively. The other special feature involving 48 elements, bordered on the thin edges or thin parts of the wedges by the alkali metals, involved a corresponding thick wedge-section after Lu, beginning with celtium (hafnium), but in developing the numbers, two sets of 17 each overlapped into the tail of the rare-earth series, and accounted for the *tendency* of an inert gas element to exist here. Hafnium (celtium) falls on the same wedge level as zirconium, but the overlap involves 4 elements not accounted for on the atomic number system. It is suggested that these may be merged with other elements, so that the atomic-number lacunæ remain as in all modern tables. These relations can

be appreciated by referring to the diagram in Part II. (see also the writer's book, "The Chemical Elements," where a progressive development of the periodic table is shown, and the limiting numbers 17 made use of). Incidentally, the form of table thus developed shows regular steps of 2, 6, 10, 14, &c., which supports the construction. The gap after U (atomic number 93) is regarded as a limiting lacuna. In this way the number 48 is established. The well-known Cu-Ag-Au triple series gives the number 21.

Having established the numbers 7, 9, 13, 21, 48, by two distinct methods, the writer next compares these values with the mean radial distances of the planets from the sun, taken in millions of miles divided by 10, and he gets fair agreements with 5 consecutive planets, counting the asteroids as collectively one planet involving a mean value of 25 instead of 21, which is the theoretical figure. Apart from the asteroids the distributed error is only 0.8 per cent.

Assuming that the whole of the planetary phenomena is analogously represented in the spectra of hydrogen, the writer compares the radial distribution of the asteroids with the distribution of the fine lines in the secondary spectrum (many-lines spectrum) of H_2 as the carrier. Diagrams are given, showing a certain parallel regularity, but it is pointed out that as all the asteroids are not mapped in the diagram, the comparison can only be regarded as suggestive, though a certain "hill and dale" agreement between the line-spectrum intensities and the crowding of the asteroids is shown. The significance of this observation will be better appreciated from what follows.

Passing from the planets to their satellites, a series of regularities is shown by using a dividing constant in order to reduce to a comparative basis the mean radial distances of the satellites from their respective primaries, as was done in the case of the planets. Treating the matter historically, the writer first makes use of values recorded in Chambers' "Handbook of Astronomy," 1889; general agreement being obtained. Then, taking later values from Ball's "Popular Guide to the Heavens," 1910, similar close agreements are obtained. Then finally using the latest values as recorded in Heath's "Popular Astronomy," 1922, on the whole better agreements are obtained. Two examples will illustrate these relationships:—

Earth: Moon, mean distance in miles: 238,840/18,346 = 13.01, the theoretical value being 13. In the case of Uranus the calculations are:—

Ariel	118,300/18,346	= 6.44	(7)
Umbriel ...	166,500	= 9.07	(9)
Titania	270,600	= 14.74	(13)
Oberon	361,900	= 19.72	(21)
Summations*		50.00	50.00

* These agree of necessity for the constant, 18,346, was evaluated from this group of satellites.

In all the calculations, the constant is derived from the satellites of Uranus, as it is suggested that, taking averages in its derivation, a minimum of perturbation is likely as a whole to influence these values as compared with those of Jupiter and Saturn, where the satellites are more numerous; but the same constant is used throughout the complete sets of satellites, taken each time.

Averaging all the values for all the satellites corresponding to the numbers 48, 21, &c., using recently-published figures, gives the following results:—

	6.58	as	compared	with	7
	9.55	,,	,,	,,	9
	13.36	,,	,,	,,	13
	20.09	,,	,,	,,	21
	48.47	,,	,,	,,	48
Averages	19.61				19.60

Cases arise in which the satellites are so near to their primary (Mars) that it becomes necessary to try the Lyman series lines for reduced values. It is known that certain alternate Balmer lines divided by 4 give the Lyman lines accurately. It was concluded, therefore, that the constant and numbers should, in this case, be divided by 4. This appears to be the case, for the distances of the two satellites is calculable thus:—

(5.58/4) × (18,346/4) = 6,398. Deimos.
Exp. value 6,000.

(13/4) × (18,346/4) = 14,906. Phobos.
Exp. value 15,000.

The value 5.58 is a continuation of the Balmer series in the ultra violet by subtracting from the ζ line 3540 and dividing by 62.5 (see above).

Other cases arise in which the values are outside the range of calculation indicated here. This suggested that the Brackett

series would correspond to these distances, and this appears to be the case when certain Balmer lines are multiplied by 4, in inverse principle the same as with the Lyman lines, when considered relatively to the Balmer lines.

There is a Brackett line of wave-length represented by the figure 26,256. Dividing this figure by 4 gives 6564, which is the Balmer α line. In the case of the other Brackett line, λ 40,500, this divided by 4 gives 10,125; then using the formula as above $(10,125-3540)/62.5 = 105$. $105 \times 4 = 420$, which agrees approximately with the value for Phœbe—the very distant satellite of Saturn—the calculated distance being $420 \times 18,346$. In a similar way, two of the very distant satellites of Jupiter may be calculated as an average value.

Considering now the Heaviside layer and the Hertz waves encircling the earth; and, moreover, the positively charged upper layer of the atmosphere—Vegard's and Bongard's theories in connection with the upper atmosphere and other matters, such as aurora displays, blueness of the sky, etc., are described at some length—and the fact that the regularity in the planetary and satellite orbits seems to indicate that they involve a "place principle," as in the Bohr atom, it is suggested that the mass of the moving entity in the case of these phenomena is only related to an *antecedent* effect and that mass is not directly related to the radial distances.

Consequently, in the case of the atom, the electron need not describe an orbit, but the orbital equivalent may be accomplished by the electron in vibration, taken as an antecedent effect. This leads to the conception of the radiation going round the atomic nucleus as a closed affair until the electron is displaced, when the closed radiation leaves the nucleus of the atom and passes away as electromagnetic radiation. The writer draws a picture thus:—

As a suggestive outcome of these studies the idea is advanced that the electron only vibrates in various stable radial positions relative to the atomic nucleus, whilst then —*i.e.*, during each practically stationary state—it gives rise to a radiation that forms essentially a circle or ellipse round the nucleus as the centre, very much as Hertz waves encircle the earth. This conception helps to remove a number of outstanding difficulties common to existing theories of the atom. For example, it reconciles the Rutherford-Bohr atom with the Lewis octet theory; the magnetic tangle, so to speak, is avoided: the quantum emissions and absorptions, as revealed spectroscopically, are easier to comprehend; the difficulty of an accelerating electron not emitting radiation is removed, since in reality the radiation is closed round the positive nucleus of the atom and then supports, as it were, the vibrating electron (the action may be mutual) which can only give out radiation when it settles into a new but definite radial position in general agreement with Bohr's theory—except that the electron does not describe circular or elliptical orbits (excluding the case of highly magnetised bodies, which is another distinct phenomenon).

This type of atom and its behaviour in respect of radiation phenomena may be illustrated on a planetary scale by considering the earth and its single satellite—the moon—representing respectively the positive nucleus of the hydrogen atom and its distantly situated electron.

Consider such a system not in rotation and in place of gravity, the negatively charged moon being attracted to the positively charged earth, but the law of attraction in this case represented, or modified, according to an equation suggested by Sir J. J. Thomson (see the writer's "The Chemical Elements," p. 161). Consider the moon vibrating along a radial line extending from the earth, so as to set up a wave in the Æther normal to this line, and which describes a circular path in space round the earth. No radiation would pass out from this world system into the stellar systems beyond until the moon was suddenly displaced to a new radial position, say one represented by that of Umbriel with respect to Uranus, where it could again vibrate without giving out an expanding-like radiation. The original radiation would then leave the earth-system as a definite bundle, and pass out into stellar space, and, in so doing, obey the laws of electromagnetic radiation.

The writer then proceeds to other phenomena, such as fluorescence, phosphorescence, after-glow in gases, and ball lightning, suggesting that the radiation may encircle charged particles or atomic nuclei when the charge is locally developed by the displacement, partially or completely, of the electrons, as by the photo-electric effect, and thus throw some light on the foregoing phenomena. Some particulars of ball lightning are quoted from G. C. Simson (*Nature*, Nov. 17, 1923), and discussed in

accordance with these views. The writer introduces a number of quotations to strengthen the lines of argument taken; and, moreover, to show kindred developments in this field of research and study.

It is concluded that the relations shown cannot be accidental ones, and therefore the groupings of the elements, whether taken *astronomically* or in the *periodic subdivision sense*, are closely represented in the spectra of hydrogen, and therefrom deductions are possible which may require a modification in the Rutherford-Bohr atom, but the theory of the nuclear part, due to Rutherford's researches, is strengthened, in the writer's opinion.

THE PREPARATION AND PROPERTIES OF SOLID ARSENIC HYDRIDE.

PART I.

By EDWARD J. WEEKS, M.Sc., A.I.C.

Arsenic hydride in the solid state appears to have been first proved to exist by J. V. Janowsky in 1874 (*Ber.*, 1874, VI., 216-220). He obtained it by decomposing sodium arsenide with acids, when he found he had a brown powder left, to which he ascribed the formula AsH.

In 1911, H. Reckleben and J. Scheiber (*Zeit. anorg. Chem.*, 1911, LXX., 255-274) found that the electric discharge on arsine gave the solid hydride, and they also confirmed the work of J. V. Janowsky. They ascribed to it the formula As_2H_2. They also made the important discovery that if arsene is passed over solid sodium hydroxide and water, a mixture of arsenic and the solid hydride results.

$AsH_3 + 3NaOH = Na_3As + 3H_2O.$

$2\,Na_3As + 6H_2O = As_2H_2 + 6NaOH + 2H_2.$

In 1920, H. Thomas and E. Hess (*Ber. Deut. Pharm. Ges.*, 1920, XXX., 483-489) confirmed the existence of the solid hydride by the action of water on calcium arsenide.

In the present work, it was thought very probable that, in view of the work of H. Reckleben and J. Scheiber (*loc. cit.*), and of the work of H. Sand, E. Weeks, and S. Worrell on the electrolytic preparation of stibine (*J.C.S.*, 1923, CXXIII., 456-470) that solid arsenic hydride might be obtained by the electrolysis of sodium hydroxide, using an arsenic cathode. The gaseous arsine produced would then be decomposed by the alkali in the manner already shown.

The cathode was a large piece of pure arsenic (Kahlbaum), suspended in a porous pot by means of platinum wire. The electrolyte chosen was a normal solution of sodium hydroxide, and a platinum anode was used exterior to the pot. A current of 100 milliamps/cm² was passed for about half an hour. Gaseous arsine was given off and on filtration of the contents of the porous pot a brown powder of solid arsenic hydride was obtained. This was then dried and examined under the microscope, when it was found to be an amorphous powder distinctly different from the original arsenic.

Further work is now being conducted to prepare the pure substance and to examine fully its solubility, etc.

The Sir John Cass Institute,
Aldgate.

STUDIES IN THE REACTIONS OF THE AMINO GROUP IN 4' AMINO 1 PHENYL 5 METHYL BENZOTHIAZOLE.

PART II.—THE ACTION OF DRY SULPHUR MONOCHLORIDE ON XYLENE SOLUTIONS OF DEHYDROTHIOPARATOLUIDINE AND CERTAIN OF ITS DERIVATIVES.

By R. F. HUNTER, F.C.S.

(*Continued from Page 36.*)

This paper contains further researches into the nature of the reactions of the amino group in 4' amino 1 phenyl 5 methylbenzothiazole. This work, as in the case of the experiments described in the previous paper, has involved the isolation of a number of new compounds containing the fused heterocyclic thiazole homocyclic bicyclic benzene ring system. The relative stability of these compounds forms an interesting subject for a later investigation.

The amino group in dehydrothioparatoluidine contains a very reactive hydrogen atom. Clearly, then, it is to be expected that this hydrogen atom will react with sulphur chloride to form hydrogen chloride at the slightest opportunity. Suppose, then, that we dissolve dehydrothioparatoluidine in a solvent which is inert as regards sulphur monochloride, then, clearly, we should expect the reactive hydrogen atom of the amino group to react according to the equation given hereunder to give the thiazole compound (2)

$$CH_3C_6H_3 < {}^{S}_{N} > C\,C_6H_4NH_2 + S_2Cl_2 =$$

(1)

$$S\,[NHC_6H_4C < {}^{S}_{N} > C_6H_3CH_3]_2 + 2HCl.$$

(2)

Similarly, we should expect the nitro derivative of dehydrothioparatoluidine to react in a similar manner in an inert solvent, that is to say, to yield the thiazole (3).

$$S\,[NHC_6H_4C < {}^{S}_{N} > C_6H_2(NO_2)CH_3]_2.$$

(3)

Similarly, dehydrothioparatoluidine dibromide might be expected to give the compound (4) according to the reaction:

$$S\,[NHC_6H_4CBr < {}^{S}_{NBr} > C_6H_3CH_3]_2.$$

(4)

and in precisely the same way the sulphonic acid of dehydrothioparatoluidine to form the complex thiazole (5):

$$S\,[NHC_6H_3(SO_3H)C < {}^{S}_{N} > C_6H_3CH_3]_2$$

(5)

A suitable inert solvent for dehydrothioparatoluidine as regards sulphur monochloride was found in the form of xylene. When dehydrothioparatoluidine was dissolved in xylene, and sulphur chloride was added, an immediate precipitate of a golden yellow appearance was formed, which was assumed to be (2), since hydrochloric acid was produced during the reaction. The other derivatives referred to in this paper unfortunately displayed too low a solubility in xylene for definite results, and as a consequence the results obtained cannot be taken as definite proof of the reaction, which is assumed to proceed as given above. One fact emerges as regards these compounds, and that is that the derivatives dealt with had their amino groups blocked owing to the method of their preparation, and therefore were unable to react in a manner similar to the free base itself, dehydrothioparatoluidine. Thus, in the case of nitro dehydrothioparatoluidine, it is clear that the compound dealt with was not nitro dehydrothioparatoluidine, but the nitrate of nitro dehydrothioparatoluidine. This is quite clear from the work on thiazole dyes, which has been communicated to the Transactions of the Soc. Chem. Ind. recently by the author, which at the time of writing is as yet unpublished. Similarly, the supposed sulphonic acid of dehydrothioparatoluidine referred to in this paper is not the real sulphonic acid, but the sulphate of the sulphonic acid. As regards the dibromo addition product of dehydrothioparatoluidine referred to in this paper is not the real dibromo derivative of this, but the acetate of this produced by the presence of the free amino group of dehydrothioparatoluidine present in the bromination.

For the above reasons it is hoped to repeat this work on the sulphur chlorination of these thiazoles once a suitable method has been derived for the preparation of the free amines containing unblocked amino groups.

Experimental.

Dehydrothioparatoluidine: (See *J.C.S.I.*, 1923, XLII., 302).

Dehydrothioparatoluidine dibromide (*The Chemical News*, 1923, CXXVII., 8323).

Mono nitrodehydrothioparatoluidine nitrate:

2 gms. of dehydrothioparatoluidine are placed in a 14° cc. beaker, and excess of concentrated nitric acid run in from a burette with constant stirring from a burette containing the acid. A vigorous reaction took place with the evolution of heat, and nitrous fumes and a deep brown liquid was produced. The beaker was warmed on a boiling water bath for an hour to complete the nitration; the hot solution was then drowned in 300 ccs. of cold water; the orange precipitate was filtered at the pump, washed with hot water, and dried on the steam. The result was nearly theoretical for the equation:

$$CH_3C_6H_3 < {}^{S}_{N} > C\,C_6H_4NH_2 + 2HNO_3 \rightarrow$$

$$CH_3C_6H_2(NO_2) < {}^{S}_{N} > C\,C_6H_4NH_2HNO_3.$$

Dehydrothioparatoluidine monosulphonic acid:

1 gm. of pure dehydrothioparatoluidine from alcohol was placed in a boiling tube with 15 ccs. of 98 per cent. sulphuric acid, and the tube heated for an hour in an oil bath at 120° C. The resulting brown liquid was then drowned in water (300 ccs.), and the yellow precipitate filtered at the pump in the usual manner, washed and dried.

Sulphur chlorination of dehydrothioparatoluidine:

1 gm. of pure dehydrothioparatoluidine was dissolved in 20 ccs. of warm xylene, and the golden coloured solution cooled under the tap. To the xylene solution of the thiazole was then added sulphur monochloride, drop by drop, from a burette charged with this compound. The first drop produced an immediate orange precipitate. More chloride was then added until an excess was present, and the beaker containing the mixture allowed to stand for some 20 minutes. The contents were then filtered, and the residue on the filter paper washed with warm xylene. A portion of the solid was then recrystallised from warm ethyl alcohol. The compound does not appear to exhibit the same tendency to tar up as the other derivatives of dehydrothioparatoluidine and dehydrothioparatoluidine itself.

The sulphonic acid, the nitro derivative, and the dibromo addition product described above, were then treated in the same way. Unfortunately, the solubilities were too low for definite results.

The Imperial College of Science and Technology,
South Kensington, S.W.7.

December, 1923.

THE ECONOMIC PRODUCTION OF CARBONIC ACID GAS.

Hitherto the carbonic acid gas used in aerated water manufacture has been either generated on the premises by the action of a mineral acid on a suitable carbonate, such as carbonate of lime or bircarbonate of soda, or it has been purchased (liquefied) in tubes, in which case it is either produced in the fermentation of alcoholic liquors, or by the burning of charcoal or coke in air and subsequent separation of the gas. In either case, whether it is prepared in the factory or purchased, the cost of the gas, exclusive of labour and power charges, works out at about the same figure, which pre-war was £14 per ton, but at the present time is about twice that amount.

Although carbonic acid from the combustion of coke is no novelty, until some years ago no suitable apparatus had been introduced for utilising this method in mineral water factories or by small consumers. A process and plant, however, have been perfected by Mr. James Leslie, whereby the difficulties which prevented the use of this method on the small scale have been overcome. The apparatus was elaborated in Mr. Leslie's factory in Belfast, and operated for some years with eminently satisfactory results; and it is with the utmost confidence now recommended for general use.

When it is remembered that the combustion of twelve parts of carbon yields forty-four parts of carbon dioxide, or three and two-thirds its own weight, and that the value of coke (which consists essentially of carbon) is in this country at present about 40s. per ton, some idea may be formed of the economy to be effected by the adoption of this process, as in actual practice about two and a half to three tons of gas are obtained from one ton of coke.

In this process the impurities originally present in the coke, or produced in the combustion and the residual gases from the air, are thoroughly eliminated; the finished product being pure carbon dioxide, CO_2.

The process and plant, although originally designed for use in aerated water manufacture, are equally suitable for chemical factories, for bakeries, refrigeration, and all industries in which carbonic acid is used. For the manufacture of liquefied carbonic acid it is specially economical, owing to the smaller initial outlay for the necessary plant; while the cost of working is considerably less, and the yield from the material much greater than by existing methods.

REPORT BY PROFESSOR LETTS.

Mr. James Leslie, having requested me to examine the method which he has patented for the manufacture of carbonic anhydride, and to investigate the gas produced by that method, with the object of ascertaining its freedom from impurities and its fitness for use in the manufacture of aerated waters, I beg to report as follows:—

The method consists in first obtaining crude carbonic anhydride by the combus-

tion of coke. The gas is then thoroughly washed with water to remove soluble impurities, and is next passed into a solution of an alkaline carbonate, when it is absorbed and an alkaline bicarbonate is formed.

This constitutes the first part of the process, while the second merely consists in heating the bicarbonate solution, when carbonic anhydride is disengaged and the original alkaline carbonate reproduced.

In short, the method consists in the alternate production and dissociation of an alkaline bicarbonate—the same quantity of alkaline carbonate serving for repetitions of the process as often as may be desired.

The economic advantages of the method appear to me to be considerable, as with the exception of the alkaline carbonate, no other chemicals are employed, and no bye-products are obtained, which have to be discharged into the sewer or otherwise disposed of. The operations are simple and easily controlled, and the cost of production of the carbonic anhydride is very much less than by the usual methods.

I have inspected the plant which Mr. Leslie has installed at his works in Belfast, and have seen it in operation on two or three occasions.

Both parts of the process, namely, the production of carbonic anhydride from coke and its absorption by the carbonate solution, with its subsequent evolution from the resulting bicarbonate, appear to work smoothly and satisfactorily, and a considerable quantity of the gas was produced and collected in my presence. I personally collected samples for chemical examination, and ascertained when doing so that so far as taste and smell are concerned, it had the usual characteristics of the carbonic anhydride ordinarily used in the manufacture of aerated waters.

As regards the chemical examination which I subsequently made, I directed my attention specially towards the detection of sulphurous anhydride, compounds of arsenic and carbonic oxide, in the carbonic anhydride finally produced in Mr. Leslie's process and collected in the usual way in a gas holder over water.

For this examination, and also for the detection of compounds of phosphorus which might possibly be present, though I scarcely anticipated that they would be, two separate experiments were performed with relatively large volumes of the gas, namely, 15 and 13 litres respectively (or about 3.3 and 2.9 gallons).

In neither case could I detect any traces of the impurities mentioned, though the test employed for arsenic I had previously ascertained to give a decided indication with 1/100 milligram of arsenious anhydride (about 1/7000 of a grain). I also made a separate analysis with the object of ascertaining the proportion of air or nitrogen in the carbonic anhydride. This gave only 0.68 per cent. by volume of such impurities, a result which compares very favourably with similar analyses which I have made of carbonic anhydride prepared from other sources and used in the manufacture of aerated waters.

I may, perhaps, add that in the process of manufacture under consideration, it is difficult to see how any impurities could be present in the carbonic anhydride finally collected. The impurities which I have mentioned as being possibly present in the crude gas as it passes from the furnace, if not removed by the preliminary treatment, should either remain fixed in the alkaline carbonate solution, or, if permanently gaseous and only slightly soluble (as in the case with carbonic oxide and atmospheric gases), they should pass away unchanged through the carbonate solution.

E. A. LETTS, D.Sc., PH.D.,
F.C.S., F.I.C., etc.
Professor of Chemistry in the Queen's College, Belfast.

GENERAL NOTES.

GERMANY'S COMMERCE AND INDUSTRY DURING DECEMBER.

Mr. J. W. F. Thelwall, Commercial Secretary at Berlin, has forwarded to the Department of Overseas Trade a review of the state of trade and industry during December.

The economic situation showed a slight improvement as compared with November. The stabilisation of the mark, the issue of a sufficient quantity of stable currency, and the almost general introduction of gold mark prices enforced exact calculation, and thus brought some stability and order once more into the whole of business life, and dispelled unrest with regard to wages.

Mining Industry.

Coal.—In Upper Silesia an agreement was arrived at with the miners' organisations regarding the prolongation of working hours. An attempt is to be made to increase the output as soon as possible to the pre-war level, taking for purposes of com-

parison the output of an underground worker per shift in the month of January, 1924, and that of a similar worker in January, 1914. Longer underground shifts of 8½ hours are to be introduced.

The Reich Commissioner for the distribution of coal has sanctioned the delivery once more of Silesian coal to the coastal localities. This welcome increase of markets will, it is true, be affected by British coal imports, the comparative cheapness of which, in view of the high rate for the Rentenmark, renders them still exceedingly capable of competition.

In the Central German brown coal district, *no increase of output has yet taken* place. Sales were, in general, satisfactory, but declined in the second half of the month, as the sugar beet season drew to a close, and customers held back with orders *in anticipation* of a further reduction in the price of briquettes.

Potash.—The stagnation of sales in the potash industry continued throughout December, but foreign sales were slightly better.

Iron.—In Upper Silesia the stabilisation of the currency greatly relieved the scrap iron market. German prices were again below the world's market level. As to finished iron, business has not yet revived. The substantial reduction in the price of Upper Silesian rolled products also failed to improve the situation. The few orders on the market were strongly competed for by Czecho-Slovakia. Orders from the wagon factories fell off, the railways having withdrawn their orders from the latter.

Zinc.—The situation in the zinc industry changed but little. Though the demand from abroad was lively, business was rendered very difficult by the strong underbidding of competitive industries.

Tin.—Tin was subject to heavy price fluctuations, but reached the highest level recorded this year on December 12, namely, about £240 per ton.

Prices of electrolytic copper were also firm. Those of zinc and lead declined somewhat.

Shipbuilding Industry.

Owing to the occupation of the Ruhr, no improvement in the position of the shipbuilding industry was possible. The prices of material were too high, and the greater part of the industry's requirements must be covered in England.

Chemical Industry.

According to the reports of the Halle, Görlitz, and Wiesbaden Chambers of Commerce, a portion of the chemical works were still well employed; others had to work subject to considerable restrictions, and could only raise with difficulty money for the payment of wages and salaries.

In the chemical preparations industry, business revived slightly. Foreign sales, however, continued to fall off. In occupied territory, owing to the interruption of goods traffic within that area and to unoccupied Germany, an extension of activities was out of the question.

Paper Industry.

In the East Prussian cellulose industry, fewer inland orders were booked than in the preceding month, as there was a falling off in production in most of the paper factories in consequence of the Christmas holidays. Foreign trade was very unsatisfactory; in spite of a reduction of export priees, no contracts with foreign customers were concluded.

PROCEEDINGS AND NOTICES OF SOCIETIES.

THE ROYAL SOCIETY.

THURSDAY, JANUARY 17.

Papers read:—

M. BROTHERTON. *Experiments on the Emission of Electrons under the Influence of Chemical Action.* Communicated by Prof. O. W. Richardson, F.R.S.

The emission of electrons from drops of the liquid alloy of sodium and potassium when acted on by $COCl_2$ has been examined over a wider range of pressures and effects than in Prof. Richardson's work.

Two methods have been devised:—

(1) The first consists in having a large volume of gas which is very slowly consumed and gives consistent results at higher pressures.

(2) The second method, in which a stream of active gas is continuously pumped through the apparatus, gives very consistent results at very low pressures.

Saturation currents ranging from 2×10^{-11} amps. to 3.8×10^{-8} amps. have been obtained.

At the higher pressures of $COCl_2$, the shape of the characteristic has been found

to vary with the pressure, but is independent of it at low pressures, although the saturation current may vary considerably.

This variation with the pressure explains the exceptional effects obtained in Prof. Richardson's earlier work.

M. D. HART. *On the Degradation of Acoustical Energy.* Communicated by Prof. A. N. Whitehead, F.R.S.

Papers read in title only:—

F. W. ASTON, F.R.S. *On the Velocity of the Positive Ions in the Crookes Dark Space.*

PROF. W. L. BRAGG, F.R.S. *The Structure of Aragonite.*

PROF. G. H. HARDY, F.R.S., and E. LANDAU. *The Lattice Points of a Circle.*

D. BRUNT. *The Dynamics of Cyclones and Anti-Cyclones regarded as Atmospheric Vortices.* Communicated by Sir Napier Shaw, F.R.S.

C. D. ELLIS, PH.D., and H. W. B. SKINNER. *The Absolute Energies of the Groups in Magnetic β-Ray Spectra.* Communicated by Prof. Sir Ernest Rutherford, F.R.S.

The wave-lengths of the characteristic β-rays emitted by radio-active bodies during disintegration can be deduced from the magnetic β-ray spectrum, and for this reason it is very important to have accurate measurements of the energies of the electron groups forming this spectrum. It is quite easy to compare the energies of different groups and to fix the scale of all β-ray groups; all that is necessary is to measure in absolute units the energies of certain of the stronger groups. Those chosen were the prominent ones of Radium B. The method used was to determine the radius of curvature of the path of the β-rays in a uniform magnetic field by the usual focussing device and to measure the magnetic field in absolute units, thus obtaining HP, and from this the energy is calculated by the relativity formula. The field was measured by a modified balance method in terms of the area turns of a search coil and the value of a mutual induction. The field used in each experiment was separately determined, and special attention was paid to errors arising from non-uniformity of the field and the susceptibility of the core of the search coil. The final values of $H\rho$ have an accuracy of 1 in 500.

C. D. ELLIS, PH.D., and H. W. B. SKINNER. *A Reinvestigation of the β-Ray Spectrum of Radium B and Radium C.* Communicated by Prof. Sir Ernest Rutherford, F.R.S.

The complete β-ray spectrum of radium B has been reinvestigated and the energies of the groups determined. Many new lines have been found. The β-ray spectrum of radium C up to $H\rho$ 2,400 has also been remeasured. The main conclusions that had been reached from former work have been strengthened, the most important being that since the β-ray lines are shown to be due to conversion of γ-rays in the various electronic levels, it is possible to deduce the wave-lengths of the monochromatic γ-rays emitted by the disintegrating nucleus. A full list of the radium B γ-rays is given, and also one of the radium C γ-rays in the region investigated. In addition, curious changes in relative absorbing powers of the L sub-groups for different frequencies are found. Further, whereas the majority of the γ-rays emitted from the radium B nucleus are converted in the radium B electronic system, atomic number 82, one γ-ray from radium B gives groups which undoubtedly come from the actual disintegrating atom, but which correspond to conversion in an atom of atomic number 83.

C. D. ELLIS, PH.D., and H. W. B. SKINNER. *The Interpretation of β-Ray Spectra.* Communicated by Prof. Sir Ernest Rutherford, F.R.S.

In a previous paper new measurements were described which gave more accurate values for the frequencies of the monochromatic γ-rays emitted by radium B and radium C. These measurements confirm strongly the conclusion that the γ-rays are due to transitions between stationary states in the nucleus, and the probable arrangement of the nuclear levels of radium B and radium C is deduced. The very interesting result is found that these two sets of levels are similar in structure, those of radium C differing from those of radium B only by having greater energy differences. The bearing of this result on the nature of the levels is discussed and put into general relation with a picture of the disintegration process. The detailed measurements of the β-ray spectra have also shown that the

relative absorbing power of the L sub-groups changes with the frequency of the absorbed radiation. The results are discussed here and shown to be probably true for the absorption of radiation in general.

H. D. SMYTH, PH.D. *Further Studies in Ionization: Hydrogen and Oxygen.* Communicated by Prof. Sir Ernest Rutherford, F.R.S.

L. F. BATES and J. S. ROGERS. *Particles of Long Range emitted by the Active Deposits of Radium, Thorium and Actinium.* Communicated by Prof. Sir Ernest Rutherford, F.R.S.

G. M. SHRUM. *The Doublet Separation of the Balmer Lines.* Communicated by Prof. J. C. McLennan, F.R.S.

The doublet separations of the first five lines of the Balmer series have been determined and found to be almost in exact quantitative agreement with the theory of Sommerfeld.

A method has been described whereby the intensity of the Balmer lines relatively to the secondary spectrum may be increased many times, even when the discharge tube is at liquid air temperatures.

No evidence of the fine structure was observed even under very favourable conditions.

The spectrum of pure hydrogen was studied when the discharge tube was at -252° C. Evidence has been deduced to show that at this temperature the greater part of the gas is in the molecular condition.

While it has been shown that a remarkable confirmation of Sommerfeld's theory has been obtained indirectly from Paschen's investigation of the structure of a number of wave-lengths in the spectrum of helium, and while it has been shown that the L series of the Röntgen spectra of the elements consists of doublets with a constant separation between the components of approximately 0.365^{-1} cm., the present values for the doublet separations of the Balmer lines represent the first direct proof of the theory in so far as the atoms of hydrogen are concerned.

THE ROYAL INSTITUTION OF GREAT BRITAIN.

The Friday evening discourse on January 24, entitled *The Future Development of London*, was delivered by SIR ASTON WEBB, K.C.V.O., C.B.

On Tuesday, January 22, PROF. W. E. DIXON, M.D., F.R.S., gave his second lecture on *Drug Addictions*.

SOCIETY OF PUBLIC ANALYSTS AND OTHER ANALYTICAL CHEMISTS.

The Annual General Meeting of the Society will be held on Wednesday, February 6, at the Chemical Society's Rooms, Burlington House, Piccadilly, W., at 8 p.m.

The accounts for the year will be presented, the President will deliver his annual address, and the election of officers and council for the ensuing term will take place. The appointment of auditor will be made.

The Ordinary Monthly Meeting of the Society will be held immediately following the Annual General Meeting, when the following papers will be read:—

Osmium Tetroxide as a Reagent for the Estimation of Tannins and their Derivatives, by C. AINSWORTH MITCHELL, M.A., F.I.C.

The Composition and Examination of Beef and Malt Wine, by G. D. ELSDON, B.Sc., F.I.C.

An Apparatus will be demonstrated for *Fat Extraction and Solvent Recovery*, by S. A. DE LACY, A.I.C.

ROYAL MICROSCOPICAL SOCIETY.

The section of the Society which has been formed to deal with the Industrial Applications of the Microscope, and to assist in the development of industrial research in British industries, held a meeting on Wednesday, January 23.

Sir Robert A. Hadfield, Bart., D.Sc., F.R.S., F.Inst.P., F.R.M.S., presided.

The programme included the following exhibits:—

Mr. W. E. Watson Baker, A.Inst.P. F.R.M.S.—A New Model Metallurgical Microscope: Model "A" Polarimeter.

Mr. Conrad Beck, C.B.E., F.R.M.S.—The New Inverted Microscope for Metallurgy.

Mr. F. N. Davidson, F.R.M.S.—The Super-Microscope.

The following communications were read:—

Some Failures in Steel as revealed by the Microscope and recorded by Photography by CAPTAIN J. W. BAMFYLDE.

The Use of the Microscope in the Petroleum Industry, by MR. H. B. MILNER, M.A., D.I.C., F.G.S., A.M.I.P.T.

The next meeting will be held on February 27, 1924, when Sir Richard A Gregory will preside.

Communications will be read by:—

MR. R. DAUBNEY, M.Sc., M.R.C.V.S., *Notes of Some Parasitic Worms of Importance to Agriculturists.*

MR. HUMPHRY J. DENHAM, M.A., F.R.M.S., *Practical Microscopy in Research on Textile Fibres.*

MR. J. E. BARNARD, F.INST.P., F.R.M.S. will give his lecture demonstration on *Technical Microscopy,* No. 3: The optical equipment required, and the need for reducing such equipment as far as possible where rapid manipulation is essential. Tests to apply to all optical parts.

THE ROYAL SOCIETY OF ARTS.

On Monday, January 21, the Cantor lecture (1), entitled *Colloid Chemistry,* was delivered by ERIC KEIGHTLEY RIDEAL, M.A., PH.D., D.Sc., F.I.C.

On Wednesday, January 23, at the Ordinary Meeting, a lecture entitled *Cinematography in Natural Colours—further developments* (with illustrations — scenes from H.R.H. the Prince of Wales's Tour in India), was given by G. ALBERT SMITH. Mr. George E. Brown, F.I.C., Editor of the British Journal of Photography, presided.

FUTURE ARRANGEMENTS.

Monday, Jan. 28, 8 p.m. (Cantor Lecture): ERIC KEIGHTLEY RIDEAL, M.B.E., B.A., PH.D., D.Sc., F.I.C., The Chemical Laboratory, The University, Cambridge, *Colloid Chemistry* (Lecture II.).

Wednesday, Jan. 30, 8 p.m. (Ordinary Meeting): SIR RICHARD ARTHUR SURTEES PAGET, BT., *The History, Development and Commercial Uses of Fused Silica.* Sir Herbert Jackson, K.B.E., F.R.S., will preside.

Monday, Feb. 4, 8 p.m. (Cantor Lecture): ERIC KEIGHTLEY RIDEAL, M.B.E., B.A., PH.D., D.Sc., F.I.C., The Chemical Laboratory, The University, Cambridge, *Colloid Chemistry* (Lecture III.).

Tuesday, Feb. 5, 4.30 p.m. (Dominions and Colonies Section): F. W. WALKER, *The Commercial Future of the Backward Races, with Special Reference to Papua.* Sir George R. Le Hunte, G.C.M.G., will preside.

Wednesday, Feb. 6, 8 p.m. (Ordinary Meeting): IYEMASA TOKUGAWA, O.B.E., First Secretary to the Japanese Embassy, *The Earthquake and the Work of Reconstruction in Japan.* Lord Askwith, K.C.B., K.C., D.C.L., Chairman of the Council, will preside.

Wednesday, Feb. 13, 8 p.m. (Ordinary Meeting): H. MAXWELL-LEFROY, M.A., Professor of Entomology, Imperial College of Science and Technology, *The Preservation of Timber from the Death Watch Beetle.* Sir Aston Webb, K.C.V.O., C.B., P.R.A., will preside

THE CHEMICAL SOCIETY.

Papers read at the Ordinary Scientific Meeting, held on January 17:—

A suggested Explanation of the Allotropic Transformations of Iron, by R. H. ATKINSON.

From Westgren and Phragmen's X-ray measurements of the crystal lattices of the different allotropes of iron the following conclusions were drawn:

The diameter of an atom of iron when not in contact with other atoms is 2.54 A.

An atom of iron is capable of being pressed out of shape; the atoms in α and β iron are deformed.

A body-centred cubic lattice made up of deformed iron atoms is stable, but a face-centred cubic lattice would be unstable.

The consequences of assuming that the forces between the iron atoms are gravitational were shown to furnish an explanation of the existence of δ, γ and α modifications of iron; the difference between β and α-iron is also explicable if ordinary iron is a mixture of isotopes, and it is predicted that all elements which are mixtures of isotopes will exhibit non-polymorphic allotropy in the solid state.

Incidentally, a mechanism of freezing was propounded according to which it should be possible to separate isotopes by fractional crystallisation of the elements.

The Activity of Water in Aqueous Hydrochloric Acid, by H. J. E. DOBSON and IRVINE MASSON.

The water-activity of a solution, as compared with that in pure water, may be measured by the ratio of its partial vapour-pressure to the vapour pressure of pure water. This has been done at 25° for hydrochloric acid of concentrations from 0 to

10.5 N, using a dynamic method which was worked out for the purpose. As examples, the activity (p/p_o) falls to 0.75 in 4.4 N acid, to 0.5 in 7.2 N, and to 0.3 in 10.0 N acid.

By a suitable application of Duhem's thermodynamic equation, on lines which have been indicated by G. N. Lewis and Randall, it is possible to calculate, independently of these data, the activities of water in hydrochloric acid solely from measurements of the electromotive force of the cell H_2/HCl Aq./AgCl, Ag. Such measurements have been made at 25°, and the activities of water deduced in this way were almost in exact agreement with the present figures directly obtained from the partial aqueous vapour-pressures.

A similar calculation from data for the partial pressures of hydrogen chloride also yield water-activities in good agreement with those observed.

The Vapour Pressure of Hydrochloric Acid Solutions, by F. S. DUNN and E. K. RIDEAL.

The vapour pressure of water and of hydrogen chloride has been measured for solutions of hydrochloric acid over a fairly wide range. The conclusions arrived at are in agreement with those of the authors of the communication just read.

The Freezing of Inorganic Hydrogels, by J. R. I. HEPBURN.

In a paper some time ago, Villiers, (*Compt. Rend.*, 1895, CXX., 322), stated that by simple freezing, inorganic hydrogels (*e.g.*, cupric hydroxide) are transformed into crystalline bodies. This has been examined by a study of the effects of prolonged freezing upon several typical inorganic hydrogels, including cupric hydroxide, zinc sulphide, manganous sulphide, ferric hydroxide, aluminium hydroxide, cupric and ferric ferrocyanides, and silicic acid. These substances were precipitated from N/10 solution and were frozen for eight hours in contact with the mother liquor. The form of the products was illustrated by photomicrographs, indicating that the products of freezing are crystalline only in a number of their physical properties, *e.g.*, reaction to polarised light, form and shape, compactness, and tendency to settle readily. In other respects they are colloidal in nature, resembling the substances from which they are prepared.

Direct evidence was advanced to support the view that these substances owe their origin to the crystallisation of ice. On freezing, each flock of the disintegrated gel is confined within a space surrounded by ice crystals, and is subjected to a considerable pressure as a result of the expansion attendant upon refrigeration. The effect of this pressure is partially to dehydrate the originally highly hydrated material, and to mould the product into the shape of the interspaces between the ice crystals taking part. The forms produced were pseudomorphs.

SOCIETY OF GLASS TECHNOLOGY.

A meeting of the Society of Glass Technology was held in the College of Technology, Manchester, on Wednesday, January 16, 1924, the President, Prof. W. E. S. Turner, D.Sc., being in the chair.

A paper by the President, on *Specifications for Glass*, formed the basis of an interesting discussion. Mr. J. H. Steele directed attention to a circular which he had received, in which the use of glass for food containers was attacked. It was further stated that glass splinters were a possible cause of appendicitis and cancer. Mr. E. A. Coad-Pryor suggested the desirability of having some open preliminary specifications based upon durability alone. What was needed was some simple test which could be easily applied in the works. Fuller specifications could be made as experience accrued. Professor Turner, in the course of his reply, said that his attention had already been directed to the circular to which Mr. Steele referred. As the matter was one of some importance to the glass industry, he had felt constrained to consult some of the leading pathological and surgical experts in this country, and to obtain their views on

Mr. Cousen summarised previous work done by the authors on this subject, and gave the results of their latest experiments. Some types of commercial glass, including modern colourless glass jars, began to turn yellow when exposed for some time to light. This happened when stacks of jars were kept for a time in the open yards of glass factories. It was now shown that glasses which had been decolourised by selenium, together with arsenic, showed this yellowing effect on exposure to sunlight. On the other hand, glasses which were originally yellow, due to the presence of selenium without arsenic, became bleached by sunlight. It had previously been observed

that the yellow selenium glasses, when reheated to temperatures of 500° to 600° C., became distinctly deeper in colour, the maximum deepening being reached at a temperature of about 550°. When, however, a number of pink glasses such as are obtained by melting batches containing selenium along with arsenious oxide or sodium nitrate are reheated at the same temperatures, distinct loss of colour occurs. This loss is slow at 525°, but is very appreciable even after an hour at 575°, the upper annealing temperature of the glass itself. Such a colour change would be obtained in a lehr when the pink glasses were being annealed, and would call for careful regulation of the temperature during the process.

A paper emanating from the Department of Glass Technology of the University of Sheffield, and entitled *Further Contributions to the Study of the Effect of Alumina in Glass*, was taken as read.

The next meeting of the Society will be held in Sheffield on Wednesday, February 20. It is proposed to devote this meeting to a consideration of recent advances in pyrometry, with practical demonstrations. the subject. The answers which he had received very definitely refuted the charge that glass splinters was a cause of either appendicitis or cancer.

The next paper considered was entitled *The Production of Colourless Glass in Tank Furnaces, with special reference to the Use of Selenium*, by A. Cousen, B.Sc., and Prof. W. E. S. Turner, D.Sc.

CORRESPONDENCE.

INVENTIONS IN 1923.

To the Editors of The Chemical News.

Sirs,—The industrial depression is clearly indicated by 3,000 less patent applications in 1923 than the total of 35,182 in 1922, which, however, was only a few less than the highest record of 36,372 in 1920.

Messrs. Rayner & Co., Patent Agents, of 5, Chancery Lane, London, also inform us that this is partly traceable to the economic situation of Europe, with its low rates of exchange, though against this there are more U.S. America patents, indicating the better monetary position of that country.

The British Patents records show there is still a strong lead in "Wireless," and there are many good household inventions patented. There are also many improvements in motor inventions, particularly of the light car type, and in "heavy" transport, while these are closely followed by interesting subjects relating to the building trade.

Foreign correspondence from all over the world points distinctly to increased business in matters relating to patents and trade marks as soon as the money exchange position is stabilised.—Yours, &c.,

Rayner & Co.,
Registered Patent Agents.

5, *Chancery Lane*, W.C.2.
January 11, 1924.

CAPITAL INVESTMENT IN THE CANADIAN MINING INDUSTRY.

In the report by Dr. Charles Camsell, Deputy Minister of Mines, Ottawa, Canada, for the fiscal year ended March 31 last, which has just been issued, the following statements appear:—

The capital invested in the Canadian mining industry is at present derived from three main sources in about the following proportions, namely: Canada, 54 per cent.; United States, 31 per cent.; Great Britain, 1 3per cent. Only about 2 per cent. is provided by other countries than those three.

The large proportion of United States capital in this country is only what might be expected because of the proximity of that country to us, but it would be to our advantage, and would result in greater cohesion in the British Empire if a larger proportion of British capital could be persuaded to invest here. To accomplish this it will be necessary to secure the confidence of the British public in mining investments in Canada, and to give a greater measure of protection than it has enjoyed in the past.

British Coal Enters the Canadian Market.

The recurrence during past years of coal shortages in Eastern Canada was responsible for a decision on the part of the Government to set up an organisation to study the causes of the shortages, to keep constantly in touch with the fuel situation, and to work out a policy for the permanent solution or reduction of fuel troubles. The Dominion Fuel Board was organised in November for this purpose, under the chairmanship of the Deputy Minister of Mines, assisted by certain technical officers from both this Department and the Department

of Interior, whose duties touch upon the coal problem. Sittings of the Board were held semi-weekly or weekly, and all its members gave generously of their time to the work of the Board. The first duty of the Board was to obtain a clear idea of the various phases of the fuel situation in Canada, and having obtained this, a programme of investigation was outlined, which will be carried out during 1923. The acute fuel area covers the province of Ontario and the western part of Quebec. Owing to the distance from our own coalfields in the west, and the apparent inability in the past of the Maritime Province coalfields to produce a sufficient quantity to meet its needs, this area has been dependent almost entirely on the United States coalfields for a fuel supply. Through the efforts of the Board, British coal producers were induced to inquire into the Canadian market, particularly on the St. Lawrence, and it is expected that a considerable quantity of British coal will be shipped to Montreal and other points during the season of 1923. The entry of British coal into the Canadian market will overcome to some extent the unsatisfactory situation in which our acute fuel area found itself of being dependent entirely on one source of fuel supply. In addition, the Board co-operated with the Government of Alberta and coal producers of that province in endeavouring to introduce Alberta coal into the Ontario markets.

NOTICES OF BOOKS.

Základy Nauky o Výživě Rostlin, napsal Dr. J. Peklo, Profesor Fakulty Chemicko-Technologické při České Technice v Praze. Stran. 284 se 74 Obrazy. Brno: Nakladatel A. Píša. 1923. Price 44 Kč.

This volume, on the *Principles of the Physiology of Plant Nutrition*, by Dr. Pekdo, who is Professor of Applied Botany at the Czech Technological Institute of Prague, is naturally intended for the students of that and similar institutes in Czecho-Slocakia, and others interested in this subject.

It is of interest to English chemists to note the type of work used in this developing country. This volume is one of a series of scientific handbooks published by Pisa in Brno.

The book deals with the main aspects of Plant Physiology in connection with the chemistry of nutrition, and contains much [illegible] in the field of symbiosis and photosynthesis. The author opens with a chapter on the absorption of mineral substances by plants. He then goes on to describe the nature of protoplasm and its function in the absorption of the inorganic compounds: a sub-chapter deals with the permeability of protoplasm in relation to this.

The next two chapters give an account of the nature of enzymes and the phenomenon of photosynthesis. Other chapters are concerned with assimilation, and the transformation of nitrogen compounds; symbiosis; katabolic processes, the respiration and fermentation in micro-organisms; and respiration in the higher plants.

A notable feature of the book is the illustrations, amongst which are reproductions of some remarkable photographs, taken with the aid of ultra-violet light, of living organisms. For example, on p. 40, a photograph of spore-mother cells of *Anthoceros* during synapsis is shown.

A full index completes and forms a valuable part of this excellent book. J.G.F.D.

New Patents.

This list is specially compiled for *The Chemical News* by Messrs. Rayner & Co., Registered Patent Agents, of 5, Chancery Lane, London, from whom all information relating to Patents, Trade Marks, and Designs can be obtained gratuitously.

Latest Patent Applications.

85—Coley, H. E.—Furnaces for reduction of ores or oxides. Jan. 2.

88—Coley, H. E.—Manufacture of barium sulphide and barium hydroxide. Jan. 2.

210—Dawson, E. G.—Manufacture of aperient salts. Jan. 3.

Specifications Published this Week.

208578—Plauson, Dr. H.—Process for the manufacture of alkali carbonates.

208656—Patrick, W. A.—Manufacture of catalytic agents.

202613—Vogel, Dr. H.—Process for the manufacture of colloidal sulphur.

Abstract Published this Week.

206954—Colloidal silver iodide.—Parke, Davis & Co., of 2951, Atwater Street East, Detroit, Michigan, U.S.A.

Colloidal sols; medicinal preparations.—Colloidal silver iodide preparations are obtained by treating with iodine or iodine solution or a solid iodine compound a colloidal solution of silver containing an oxidised protein substance. The colloidal solution of silver may be obtained by boiling precipitated silver oxide with a solution of gelatine, the silver being reduced and the gelatine oxidised. As a protective colloid a solution obtained by boiling gelatine with sodium hydrate solution may be added. The liquid is ground with iodine in a mortar, decanted, neutralised with acetic acid, and filtered. It may be evaporated to dryness, the product being soluble in water.

Messrs. Rayner & Co. will obtain printed copies of the published specifications and abstract only, and forward on post free for the price of 1s. 6d. each.

THE CHEMICAL NEWS,

VOL. CXXVIII. No. 3329.

STUDIES IN THE REACTIONS OF THE AMINO GROUP IN 4′ AMINO 1 PHENYL 5 METHYL BENZOTHIAZOLE.

PART V.—THE METHYLATION, ETHYLATION, AND BENZOYLATION OF 4′ AMINO 1 PHENYL 5 METHYLBENZOTHIAZOLE.

By R. F. HUNTER, F.C.S.

(*Continued from Page* 56.)

Green (*J.C.S.*, 1889, LV., 227) states that dehydrothiotoluidine is methylated by methyl iodide to dimethylde hydrothiotoluidine and to trimethyl ammonium dehydrothiotoluidine iodide. The details given are very scanty, and for this reason it was decided to repeat the work. In this paper the observation is also made that on heating, the ammonium compound splits off methyl iodide regenerating the dimethyl compound. This has the structure (1).

Dehydrothiotoluidine was, therefore, methylated by refluxing for a considerable time on a water bath with methyl iodide, the water bath was then allowed to run dry, and the heating allowed to continue for the realisation of the second reaction; that is to say, the demethylation of the ammonium compound to the dimethyl derivative. A certain amount of iodine results in this decomposition. The methylated product was then shaken with a fairly large quantity of concentrated hydrochloric acid, and the solution boiled for a short time and allowed to stand, to allow for the conversion of iodide into chloride. The resulting brown liquid was drowned in ammonia, which dissolves the iodine, neutralises the acid, and produces the free base. The product was filtered and washed and dried.

$$CH_3C_6H_3 \underset{N}{\overset{S}{<\;>}} C\,C_6H_4N(CH_3)_2.$$

(1)

$$CH_3C_6H_3 \underset{N}{\overset{S}{<\;>}} C\,C_6H_4NEt_2.$$

It was thought to ethylate dehydrothio toluidine in a similar manner, using ethyl bromide as an ethylating agent. Dehydrothiotoluidine dissolves in ethyl bromide to a brown solution. On refluxing for some time a brown solid separates, which is presumably the ethylated product. This was filtered off, dried from any ethyl bromide, and the product was an orange brown solid, probably (2). Since dehydrothiotoluidine acetylates normally to give the acetyl compound (3), we should expect it to yield the benzoyl derivative (4) under suitable conditions. This was isolated and purified as described in the experimental part of this paper.

$$CH_3C_6H_3 \underset{N}{\overset{S}{<\;>}} C\,C_6H_4NHCOCH_3.$$

(3)

$$CH_3C_6H_3 \underset{N}{\overset{S}{<\;>}} C\,C_6H_4NHCO\,C_6H_5.$$

(4)

A brom-addition product was isolated from the crude benzoyl compound by the author some time ago (*loc. cit.*). This observation has been confirmed, using the pure product prepared as stated hereunder, and brominating in alcoholic solution. The low solubility of the compound in alcohol is a disadvantage, however, the solubility in glacial acetic acid is not much better, and there is the danger of hydrolysis on prolonged boiling with the latter. Appreciable precipitation does not take place immediately on adding bromine; only a cloudiness results. On standing, a fine brown precipitate, containing bromine, comes down, but the yield is very, very poor, and insufficient for analysis even from quite a large volume of alcoholic solution. The addition of water produces a further quantity of precipitate, but then again this will precipitate unchanged benzoyl compound. However, it is hoped to find a method of isolating the benzoyl brom-product in a state of purity—the great difficulty in dealing with all these brom compounds, since the bromination proceeds according to the

$$C_{14}H_{10}NS.NHCO\ Ph + 2\ Br =$$

$$CH_3C_6H_3 \left\langle {S \atop NBr} \right\rangle CBr\ C_6H_4NHCO\ C_6H_5.$$

is that we have bromine atoms directly linked to nitrogen in our products, and the stability as a consequence is very low. Thus, acetyldehydrothiotoluidine dibromide decomposes with the splitting off of bromine by merely washing with warm water. Boiling water will remove bromine even from dehydrothiotoluidine dibromide itself (5). The most stable brom compound isolated by the author appears to be that derived from the bromination of benzal dehydrothiotoluidine in alcoholic solution, to which the formula (6) has been assigned. The bromination of these compounds is, however, being treated by the author as another series of researches under the title of "The bromination of thiazoles," the first part of which is now complete and will appear in due course.

$$CH_3C_6H_3 \left\langle {S \atop NBr} \right\rangle CBr\ C_6H_4NH_2.$$

(5)

$$H_3C_6H_3 \left\langle {S \atop NBr} \right\rangle CBr\ C_6H_4\ NHCH\ C_6H_5.$$

(6)

Experimental.

Dehydrothiotoluidine, 4′ Dimethylamino 1 Phenyl 5 Methylbenzothiazole:

2 gms. of dehydrothiotoluidine, purified as above, are mixed with 10 ccs. of methyl iodide in a 500 cc. round-bottomed flask fitted with a water condenser, is heated for two to three hours on a boiling water bath. The water bath is then allowed to run dry, and the heating continued, when a fair quantity of methyl iodide breaks up, splitting off iodine. The heating is continued for about 40 minutes. The flask is then allowed to cool, and 50 to 100 ccs. of concentrated hydrochloric acid added, the flask is heated, and the acid boiled for some time. The flask is allowed to stand for 12 hours, and the contents filtered through glass wool. The filtrate is drowned in cold dilute ammonia, when precipitation takes place. Strong ammonia is then added till a strong excess of the latter is present. The beaker containing the product and solution is then heated for some time and the solution filtered hot. The precipitate is washed on the filter paper with boiling water to remove traces of ammonium iodide, etc. The precipitate is allowed to drain in the funnel and then dried. The product is a bright orange solid.

Ethylation of dehydrothiotoluidine:

1 gm. of dehydrothiotoluidine is dissolved in ethyl iodide, by gently warming, to a brown solution in a 500 cc. flask fitted with a reflux water condenser. The solution is refluxed for a number of hours on a boiling water bath, when an orange solid appears during the refluxing. The solid is filtered, and the product warmed gently to remove any ethyl bromide. The product is an orange yellow solid.

4′ Benzoylamino 1 Phenyl 5 Methylbenzothiazole:

2 gms. of dehydrothiotoluidine and 8 ccs. of benzoyl chloride are placed in a 4-inch basin, and the mixture stirred till a uniform semi-orange paste is obtained. The basin is then heated on a boiling water bath for two hours, the mixture being stirred from time to time with a glass rod. Boiling water is then added, and the solution of benzoic acid filtered off. The process of addition of hot water boiling and filtering off is continued until only a trace of benzoic acid remains. The product is then filtered, and then washed with hot water to remove the last traces of benzoic acid. The compound is then dried. The boiling water hydrolyses the unchanged benzoyl chloride. The benzoyl compound was found to dissolve in hot alcohol. Part of the benzoyl compound was therefore recrystallised from alcohol by refluxing, allowing to crystallise after filtration into a distilling flask, and the removal of the bulk of alcohol by distillation. Fine pale yellow crystals are obtained in this manner. The yield is nearly theoretical.

Bromination:

A small quantity of benzoyl compound is dissolved in alcohol by boiling, the alcoholic solution is allowed to cool, and bromine added drop by drop from a burette with stirring. A fine cloudiness appears, excess bromine is run in, and the solution allowed to stand, when a fine yellow brown precipitate appears after some hours. This

can be filtered off and washed with a small quantity of alcohol, and dried.

A further yield of dibromo derivative can be obtained by the addition of cold water. This, however, will also precipitate any unchanged benzoyl compound.

The Imperial College of Science, South Kensington, S.W.7.

January, 1924.

CRITICAL STUDIES ON METHODS OF ANALYSIS.*

I.—NICKEL.

By LEON A. CONGDON AND CARL H. BELGE.

(Contribution from the Department of Chemistry, Syracuse University.)

INTRODUCTION.

After consulting the literature on the methods of analysis for the quantitative estimation of nickel, three methods generally used as standard ones were selected to be critically studed, namely: (1) O. Brunck's Alpha-dimethyl-glyoxime gravimetric method, (2) T. Moore's Potassium Cyanide volumetric method, and (3) Carnot's gravimetric oxide method.

PRINCIPLES OF THE METHODS.

O. Brunck's alpha-dimethyl-glyoxime gravimetric method is based on the precipitation in clear solution of the sample with alpha-dimethyl-glyoxime in alcoholic solution, the precipitate, after filtering and washing in weighed Gooch crucible and drying for two hours at 110° to 120°, contains 20.32 per cent. of nickel.

T. Moore's potassium cyanide volumetric method depends on the formation of the complex double cyanide, Ni $(CN)_2$ KCN, by means of KCN and the Ni $(CN)_6$ with $AgNO_3$ as indicator, and making corrections for the indicator used.

A. Carnot's estimates, Ni by adding Na_2CO_3 in slight excess to the solution until alkaline, then precipitates with NH_4OH or $(NH_4)_2$ CO_3 in boiling solution, the precipitate filtered and ignited to the oxide, NiO, and weighed as such.

EXPERIMENTAL.

The sample used with all methods was the purified salt of $NiSO_4$ $(NH_4)_2$ SO_4·$6H_2O$, which contained a trace of iron and 0.204 per cent. of cobalt.

In Brunck's alpha dimethyl glyoxime gravimetric method, 4.782 grams of the sample were dissolved in water and made up to a litre with water, and 50 cc. aliquots were taken for analysis.

In T. Moore's KCN volumetric method, 2.695 grams of the sample were dissolved in water and made up to 250 cc. with water, and 50 cc. aliquots were taken for analysis.

In the A. Carnot's gravimetric oxide method, 6.6621 grams of the sample were dissolved in water, made up to a litre, and 50 cc. portions used for analysis.

The following table gives the results of analyses:—

TABLE I.

Method used.	Weight of sample grams.	Nickel obtained. Per cent.	Theoretical nickel in salt. Per cent.	Avge. deviation from theoretical.	Per cent.
O. Brunck's ...	0.2391	14.89	14.89	0.00	-0.03
	0.2391	14.81		-0.07	
T. Moore's ...	0.539	14.90	14.89	+0.01	+0.03
	0.539	14.95		+0.06	
A. Carnot's	0.0333	14.31	14.89	-0.58	-0.50
	0.0333	14.26		-0.63	

* The first of a series of critical studies on quantitative methods of analysis of the elements.

(1) O. Brunck, *Zeit. Angew. Chem.*, 1907, XX., 1844; *Stahl und Eisen*, 1907, XVIII., 331; also see Prettner, *Chem. Zeit.*, XXXIII., 396; T. Schugself, *Ber.*, XXXVIII., 2520.

(2) T. Moore, *Chem. News*, 1889, LIX., 160, 292; also see E. D. Camphell and W. H. Andrews, *Jour. Amer. Chem. Soc.*, 1895, XVII., 125; J. H. Stanley, *Jour. S. Africa Assoc. Anal. Chem.*, 1921, X.

(3) A. Carnot, *Jour. Chem. Soc.*, 1918, II., 133.

Summary and Conclusions.

1.—From the Table 1. it is evident that O. Brunck's alpha-dimethyl-glyoxime gravimetric method is the most accurate of the three so-called standard methods of analysis tested.

2.—No difficulty was experienced in using any of the three methods of analysis tested, as checks were easily obtained by each method.

3.—It is concluded that the three so-called standard methods for nickel can be classed as to their accuracy in the following order:—1st, O. Brunck's alpha-dimethyl-glyoxime gravimetric method; 2nd, T. Moore's KCN volumetric method; and 3rd, A. Carnot's oxide method.

4.—For rapid work, T. Moore's KCN volumetric method for nickel is the most accurate rapid method known.

CRITICAL STUDIES ON METHODS OF ANALYSIS.*

II.—Chromium.

By Leon A. Congdon and Roger K. Gurley.

Introduction.

The methods selected from so-called standard ones for the study on the quantitative estimation of chromium were the following five, which seemed to show possibilities as to accuracy:—

(1) Precipitation of chromate with barium acetate solution.

(2) Precipitation of chromate with mercurous nitrate solution.

(3) Precipitation of chromium as chromic phosphate.

(4) Volumetric iodometric determination of chromium; and

(6) Iron permanganate volumetric determination of chromate.

Principles of the Methods.

1st.—Precipitation of the chromate with barium acetate solution. To the samples taken for analysis were added 150 cc. of water and heated to boiling, then 30 cc. of barium acetate solution (42.4 grams BaO *slightly acid with acetic acid made up to* a litre) was added, and finally 10 cc. of 95 per cent. alcohol. After settling about 10 minutes, the precipitate of barium chromate was filtered through filter paper and washed with 1 to 12 alcohol solution. The precipitate was then dried in an air oven and ignited, in a platinum crucible.

2nd.—Precipitation of the chromate with mercurous nitrate solution. This method consists of the precipitation of the monochromate with mercurous nitrate solution at the boiling temperature, and ignition of the voluminous orange precipitate to green Cr_2O_3 by volatilization of mercury. The best results were obtained by using a sample of 1.6 grams of the $K_2Cr_2O_7$ brought to boiling with 2 grams Na_2CO_3, then a saturated solution of pure mercurous nitrate in 1/10th solution conc. HNO_3 (free from NO_2) was slowly added in slight excess, and the *solution boiled to change the amorphous* brown precipitate to the orange crystalline *form. The precipitate was washed in hot* water, dried, and ignited in porcelain crucibles to constant weight. Three hours over a Meker burner gave constant weight.

3rd.—Precipitation of chromium as chromic phosphate. By this method the chromate is dissolved with a sufficient amount of alkali phosphate to precipitate

* *The second o fa series of critical studies on quantitative methods of analysis of the elements.*

(1) Pearson, A. H., and Richards, T. W., *Zeit. Anal. Chem.*, 1870, IX., 108.

(2) Rose, H., *Pogg. Ann.*, LIII., 124. (Modification of method suggested by Berzelius).

(3) Crookes, "Select Methods in Chemical Analysis," p. 127.

(4) Groger, Max, *Zeit. Anorg. Chem.* 1919, CVIII., 267-272; Kolthoff, I. M. and Vogelenzang, E. H., *Pharm. Weekblad*, 1920, LIX., 401-15. (Modifications of methods suggested by Bunzen, Fresenius and Mohr). See Sutton, F., "Volumetric Analysis."

(5) Galbraith, Wm., *Chem. News*, 1873 XXV., 151; Sell, W. J., *Chem. News* 1879, XXXIX., 181; *Jour. Chem. Soc.* May, 1879; Barba, *Iron Age*, LII., 158 Moir, J., *Jour. S. Afric. Assoc. Anal Chem.*, 1919, II., 9-16.

the chromium as chromic salt, and is brought to boiling. Sodium thiosulphate and an equivalent amount of acetic acid are then added (the acid first) and the solution boiled an hour. The green precipitate is washed with hot dilute ammonium acetate solution, dried,. and ignited, the ignited precipitate said to contain 51.86 per cent. of Cr_2O_3.

4th.—Volumetric iodometric determination of chromium. This method depends upon the principle of the action of dichromate and dilute H_2SO_4 on an excess of KI solution, the iodine set free estimated by standard sodium thiosulphate solution.

5th.—Iron-permanganate volumetric determination of a chromate. This method depends upon the principle of adding an excess of standard ferrous ammonium sulphate to a solution of the dichromate, the excess of ferrous salt being determined by standard $KNmO_4$ solution.

EXPERIMENTAL.

The sample used with all methods was recrystallized chemically pure $K_2Cr_2O_7$.

In the method of precipitation of the chromate with barium acetate solution, samples weighing 0.75 gram were dissolved in 150 cc. of water and used for the estimation.

In the mercurous chromate precipitation method, the best results were obtained by using samples of 1.6 grams of $K_2Cr_2O_7$ and by ignition of the precipitate over a Meker burner until constant weights were obtained in this method. This method was not found very satisfactory, due to the instability of the mercurous nitrate solution, the nitrites formed tending to reduce the chromate. The boiling with excess mercurous salt also tends to reduce the precipitate. In the ignition of the precipitate, there was also difficulty of driving off the last trace of mercury.

In the gravimetric chromic phosphate method, samples were taken in amounts of 0.55 grams in duplicate, and also 0.75 grams in duplicate, and the reagents added calculated to be in slight excess, but the results were not at all concordant—the excess obtained in the results seeming to point to the formation of insoluble complexes. Not all the chromium was precipitated even with excess of thiosulphate and phosphate, as the Na_2O_2 fusion test showed.

Th eiodine volumetric titration method was carried out by using 20 cc. of 1:8 KI solution and 15 cc. dilute H_2SO_4, and 25 cc. of the $K_2Cr_2O_7$ solution (1.7438 grams per 25 cc.). This solution was then titrated with $\frac{N}{10}$ $Na_2S_2O_3$, using starch as indicator.

The volumetric ferrous salt-permanganate method was used on one half-gram samples of the $K_2Cr_2O_7$. These samples were dissolved in 40 cc. of water and 5 cc. of dilute H_2SO_4 added, then 115 cc. of $\frac{N}{10}$ $Fe(NH_4)_2(SO_4)_2$ solution, and finally the excess of ferrous ammonium sulphate titrated with $\frac{N}{10}$ $KMnO_4$.

The following table gives the results of analyses:—

Method used.	Weight of sample grams.	Cr_2O_3 obtained. per cent.	Theoretical Cr_2O_3. per cent.	Average deviation from Theoretical. per cent.
Gravimetric	0.75	51.48	51.67	-0.17
Barium		51.47		
Acetate		51.46		
Gravimetric	1.60	51.32	51.67	-0.52
Mercurous		51.27		
Nitrate		51.05		
		50.94		
Gravimetric	0.55	69.8	51.67	+11.10
Chromic	0.55	70.7		
Phosphate	0.75	56.3		
	0.75	54.8		
Volumetric	0.1744	51.79	51.67	+0.12
Iodometric		51.78		

Summary and Conclusions.

1.—A comparison of the five methods studied for the estimation of chromium shows the accuracy to be as follows, beginning with the most accurate: (1) Volumetric iodometric method; (2) Gravimetric barium acetate method; (3) Volumetric permanganate method; (4) Gravimetric mercurous nitrate method; and (5) Gravimetric chromous phosphate ethod.

2.—The gravimetric chromous phosphate method is out of the question for use as a quantitative method, since non-concordant results are obtained, and the method is too inaccurate for practical use.

3.—The volumetric iodine-thiosulphate method is the most accurate and rapid one for the estimation of chromium.

4.—The gravimetric barium acetate ethod is the most accurate gravimetric process for chromium.

CRITICAL STUDIES ON METHODS OF ANALYSIS.

III.—Manganese.

By Leon A. Congdon and Joseph L. Neal, Junr.

(Contribution from the Department of Chemistry, Syracuse University.)

Introduction.

The literature was consulted for the estimation of manganese, and there was found some 28 methods suggested for the determination of this element—fourteen of these methods being volumetric ones, and the remaining number being gravimetric and colorimetric methods. It was decided to test three methods which gave promise for successful work. These methods are all volumetric ones, and were as follows: (1) Von Knorre's Persulphate process, (2) Schneider's Bismuthate method, and (3) Deshay's Lead Dioxide process.

(1) Knorre, Von, *Zeit. Angew. Chem.*, 1901, 1149; Nicolardot, P., Re Glade, A., and Geloss, M., *Compt. Rend.*, 1920, CLXX., 808-10.

(2) Schneider, *Dingler's Polytech. Jour.*, 1893, 269, 224; Reddrop, J., and Ramage, H., *Jour. Chem. Soc.*, 1895, LXVII., 268; Blair, A. A., *Jour. Amer. Chem. Soc.*, 1904, XXVI., 793; Blum, W., *Jour. Amer. Chem. Soc.*, 1912, XXXIV., 1379.

(3) Deshays, M., *Bull. Soc. Chim.*, June 20, 1878, No. 12; *Chem. News*, 1878,

Principle of the Methods.

These well-known volumetric methods for manganese are more or less indirect ones in which a $KMnO_4$ standard solution is used after the manganous salt has first been oxidized to MnO_2 by various reagents or the manganous salt has been oxidized to permanganic by various reagents with $AgNO_3$ used as catalyst; in either case an excess of a known amount of ferrous salt or sodium arsenite has been added, and the excess of ferrous salt or sodium arsenite determined by standard $KMnO_4$ solution.

Of the three methods used in this work the reagents for oxidation were: 1st, ammonium persulphate; 2nd, sodium bismuthate; and 3rd, lead peroxide. Where the persulphate was used for oxidation, the reducing substance for titration was a standardized solution of sodium arsenite, likewise in the lead peroxide method. Ferrous ammonium sulphate was used in the bismuthate method for the reducing substance.

Experimental.

The sample used with all methods was a standard steel sample from the U.S.A. Bureau of Standards, Department of Commerce, No. 8b, Bessemer steel, having the following analysis:—0.1 per cent. carbon, 0.003 per cent. silicon, 0.104 per cent. phosphorus, 0.103 per cent. sulphur, 0.020 per cent. copper, 0.008 per cent. chromium, 0.008 per cent. nickel, and 0.006 per cent. vanadium. The per cent. of manganese certified by eight independent analysts ranged from 0.385 to 0.394—the average per cent. being 0.391. The method of analysis was the bismuthate process. One investigator also reported an analysis by the persulphate process, arsenite titration, and obtained 0.39 per cent. of manganese.

The persulphate process presented no difficulties in this investigation, and consisted essentially of dissolving the steel sample in HNO_3 (Sp. Gr. 1.135), and then oxidizing the manganese present by $(NH_4)_2S_2O_8$, using $AgNO_3$ as a catalyst. The NH_4MnO_4 was then titrated against Na_2HAsO_3 previously standardized against $KMnO_4$ of known strength, or against another steel sample of known manganese content. Both methods of standardization were used.

The bismuthate process presents some difficulties, among which is the removal of NO and other nitrous fumes, the presence of which is fatal to the determination. For the removal of this difficulty a known

ımount of Fe $(NH_4)_2SO_4$ may be used, but ɔetter results were obtained by the authors ɔy using an excess of $Na_2S_2O_3$. When an ·xsess of $Na_2S_2O_3$ was nsed, excellent re-ults were obtained, and the removal of all ıitrous fumes assured. The sodium bis-nuthate used must be free from chlorine nd manganese. If such cannot be ob-ained, the sodium bismuthate may be nade by fusing bismuth subnitrate and austic soda, and then thoroughly washing he resultant product. Good results were btained by use of this laboratory product.

The red lead or lead peroxide process pre-ented no difficulties, and is similar to the ther processes.

The interfering substances in the case of he persulphate process are W, V, Cr (7.1 er cent.). All these substances are re-ıoved by precipitation with ZnO emulsion. None of these substances was present in in-erfering amount in the sample used in this tudy.

The following table gives the results of his comparative study of methods:—

From the table of results obtained, it is concluded that of the three methods of analysis investigated there is little to choose in the matter of accuracy. The persulphate method, however, has decidedly a lead on the others in the matter of time. A good persulphate test can be easily run in ten minutes, while half-an-hour is good time for either of the other methods. This is, of course, not taking into consideration the time required for standardizing the volumetric reagents, which is practically the same in all instances.

SUMMARY AND CONCLUSIONS.

1.—Three volumetric methods for determining manganese were investigated on a sample of standard steel sample from the Bureau of Standards, U.S.A. Department of Commerce. The results of these methods showed that all three methods (persulphate, bismuthate, and lead dioxide) were accurate within experimental errors with those submitted for the sample by the Bureau of Standards.

Wt. Sample grams.	Process.	P.c. Mn in Sample.	P.c. Mn obtained.	Avge. p.c. Mn obtained.	Diff. p.c.
0.1	Von Knorre's Persulphate	0.391	0.389		
			0.384		
			0.380		
			0.384	0.386	-0.005
			0.386		
			0.391		
0.5	Schneider's Bismuthate	0.391	0.394		
			0.392		
			0.387		
			0.389		
			0.383	0.388	-0.003
			0.388		
			0.384		
			0.390		
0.5	Deshays' Lead Peroxide	0.391	0.384		
			0.396		
			0.393	0.392	+0.001
			0.396		

2.—The persulphate method was the nost rapid method used, and is practically hree times as rapid a method as those of he bismuthate or dioxide. One reason that he bismuthate or lead dioxide method re-quires more time is that they both require filtration. Also that the lead dioxide process requires the oxidized solution to be cooled in the dark.

LIME MAKING FOR CALCIUM ARSENATE.*

By Howard W. Ambruster, New York.

An extensive market is being developed for high-grade chemical lime for boll-weevil control in the South. Alfalfa weevil and other insects are also fought with this new arsenical compound.

American lime producers, with one or two notable exceptions, have shown very little interest thus far in the requirements for their product for the manufacture of calcium arsenate. This lack of interest justifies itself from the fact that the total required was small, and the buyers, from the producers' standpoint, were fussy about quality to an unwarranted degree.

But recent developments in the use of calcium arsenate for boll-weevil control in the South have brought about a change in this condition. Lime manufacturers who are keen to develop new business, and who have the proper lime-stone and facilities for turning out high-grade chemical lime, are beginning to realise that this one requirement for calcium arsenate will probably attain sizable proportions within the next few years, and it is good business policy therefore to endeavour to supply for this purpose a high-grade lime of correct chemical analysis.

Amount of Lime Required.

The amount of lime required for calcium arsenate is approximately one-half the total of the finished product. Allowing for loss in storage and operations, it can be figured at 55 per cent. for the purposes of this article. In past years the largest consumption of calcium arsenate was only a few thousand tons, but this season, though accurate figures are not yet obtainable, there was a total used of between 7,000 and 10,000 tons, and a much larger quantity would have been purchased by the cotton growers if they could have secured it at the time it was needed in July and August. In the past the record of this insecticide has been most erratic, and the economic value of this method of fighting the boll-weevil was open to question, save among those pinned their faith to the intelligent and far-seeing policy of B. R. Coad, the government entomologist, who is primarily responsible for the initial use of calcium arsenate for this purpose; also for the educational campaign in which he has persisted with such tenacity to compel the manufacturers to supply a proper material and to teach the planter how to use it.

Speculation as to just how great a tonnage of calcium arsenate will be used in coming years is idle at this time. The maximum figures are too large to be used as a basis for intelligent planning on any phase of the industry.

Its Success as a Boll-Weevil Control.

But now that cotton dusting is about over for the season, and the results obtained are available for consideration, it can be stated as a positive fact that calciu marsenate has come into its own as a successful method of boll-weevil control. There is nothing in sight which can show this accomplishment. The result must be a requirement for many times the previous consumption, provided the product can be delivered to the cotton planter at a sufficiently low price. Not only are all of the existing manufacturers of insecticides planning on increased production and better methods of distribution, but new enterprises for the manufacture of calcium arsenate are starting up all over the country. The importance of this insecticide for the moment overshadows all other forms of agricultural sprays.

So while there will be no endeavour made in this brief article to indicate the total amount of lime which will be used ultimately by the calcium-arsenate manufacturers, the progressive lime producer need only assure himself that he has the facilities to warrant more attention to this part of his market than in the past.

Our difficulty has arisen in the contact between the calcium-arsenate maker and his lime supply. The former has endeavoured to buy his supply on a basis of exact chemical analysis. The latter has responded that his chemical lime is good enough for this or that other purpose, and he is not going to reorganise his quarry and kiln departments for a few hundred tons of lime.

Must be High Grade and Uniform.

The lime producer must realise, however, that the raw lime required for the calcium content in a compound made for rigid

* Reprinted from "Rock Products," Chicago, Ill.

chemical specifications must be high grade and of a uniform quality, or the cost of manufacture of this dusting material and the danger of an inferior product will be so increased as to give the buyer just cause to look for another source. Lime which will be satisfactory for other insecticides, like lime sulphur solution or Bordeaux mixtures, and for other chemical uses such as the wood pulp and tanning industry, may be absolutely unsuitable, or at least hazardous for the calcium-arsenate maker.

Of course, the prime requisite is the highest calcium oxide content obtainable. Buyers frequently insist on a percentage of from 95 to 96 per cent. CaO, and there should be no reason why the lime producer could object to an actual guarantee of this test.

Any appreciable amount of magnesia in the lime is fatal to its use for calcium arsenate, as the presence of magnesia in the final product will get the maker into trouble with the government officials.

More than a trace of iron and alumina is also objectionable, hut there is usually less difficulty on this score than on the magnesia; it is the latter which is associated so frequently with the limestone formations.

The preparation of the lime should also be such as to preclude the presence of any calcium carbonate remaining in the lime as shipped, and this factor and the physical condition have to do primarily with the operation of the producing plant.

Durink the World War and the period immediately afterward, when all raw materials were scarce and pressure for production caused slack control of labour, the lime producers shipped great quantities of so-called chemical lime which, while fairly satisfactory as to analysis of the lime itself, had so much silica and core mixed in with it as to be almost unusable for a product like calcium arsenate. The excuse of necessity no longer exists, and if the lime manufacturers can be brought to believe that the intelligent chemical manufacturer is willing usually to pay a premium to get a proper source of supply for his lime, it should not take a great while to standardise this important raw material for those industries like calcium arsenate, where chemical control is a vital necessity.

WHAT REQUIREMENTS ARE NEEDED.

It is not the purpose of this article to advise the lime maker how he should get these results, but it is desirable at this time to indicate to him what is needed for a requirement which bids fair to widen his market and improve his selling price.

The uses of lime are so diversified and the requirements so at variance, that many of the lime men seem to think it is not worth while to give attention to any problems but tonnage and cost, and they refuse to accept the fact that they are marketing a chemical product.

In its use in calcium arsenate it is strictly a raw material, and functions in a number of entirely different though related ways: as a chemical carrier for the poison; as a distributor to permit the widest possible area of effect; as an inhibiting agent to moderate the effect of the poison and prevent injury to the plant, and finally, as an adhesive to hold the poison on the plant until the weevil is destroyed.

In conclusion, the statement should be made that the possible increase in demand for chemical lime for calcium arsenate does not depend by any means on boll-weevil control alone; the alfalfa weevil, a serious menace in the West, is also being fought successfully with this arsenical compound, and the use of calcium arsenate is already established as a standard insecticide for orchard and truck sprays.

GENERAL NOTES.

CANADIAN MINERAL PRODUCTION IN 1923.

The mineral production of Canada advanced about 12 per cent. in 1923 to a total of \$214,102,000, as compared with \$184,297,242 in 1922, and the record value of \$227,859,665 attained in 1920, according to a statement issued by S. J. Cook, chief of the mining branch of the Dominion Bureau of Statistics, Ottawa, who has just completed a preliminary survey of the mineral industry. It is pointed out that commodity prices, which reached a peak in 1920, have since receded, and this fact must be borne in mind when production is computed in terms of values. A weighted index, showing the volume of production, would undoubtedly mark 1923 as the banner year in Canada's mineral industry.

New output records were established for coal, lead, zinc, asbestos, and the total value of cobalt. Copper production was more than double the tonnage produced in

1922, and nickel increased practically three and one-half times. Gold and silver were slightly lower than in 1922. A group of non-metallic minerals, including about 20 commodities, increased two million dollars to a total of $19,000,000. Structural materials and clay products, including portland cement, showed little change in the aggregate value, the total for the year being estimated at 38.9 million dollars.

PROCEEDINGS AND NOTICES OF SOCIETIES.

THE ROYAL SOCIETY.

THURSDAY, JANUARY 31.

Papers read:—

A. MALLOCK, F.R.S. *Summary of the Results obtained from Experiments made during the years* 1918 *and* 1923 *of the Effects of Temperature on the Properties of Metals.*

A. K. GOARD and E. K. RIDEAL. *Catalytic and Induced Reactions. Parts I. and II.* Communicated by Prof. T. M. Lowry, F.R.S.

Papers read in title only:—

PROF. H. B. DIXON, F.R.S., and G. GREENWOOD. *On the Velocity of Sound in Gases and Vapours, and the Ratio of the Specific Heats.*

J. R. PARTINGTON, D.Sc., and A. B. HOWE. *The Ratio of the Specific Heats of Nitrogen and of Oxygen.* Communicated by Prof. H. B. Dixon, F.R.S.

S. BARRATT. *The Absorption Spectra of Mixed Metallic Vapours.* Communicated by Prof. T. R. Merton, F.R.S.

E. P. METCALFE and B. VENKATESACHAR. *On Selective Absorption by Luminous Mercury Vapour.* Communicated by Prof. A. W. Porter, F.R.S.

THE ROYAL SOCIETY OF ARTS.

On Monday, January 28, the Cantor lecture (II.), entitled *Colloid Chemistry,* was delivered by ERIC KEIGHTLEY RIDEAL, M.A., PH.D., D.Sc., F.I.C.

On Wednesday, January 30, at the Ordinary Meeting a paper entitled *The History, Development and Commercial Uses of Fused Silica,* was read by SIR RICHARD ARTHUR SURTEES PAGET, BT. Sir Herbert Jackson, K.B.E., F.R.S., Vice-President, presided.

THE ROYAL INSTITUTION OF GREAT BRITAIN.

The Friday evening discourse next week (February 1, at 9 o'clock), will be delivered by SIR WILLIAM BRAGG, K.B.E., D.Sc., F.R.S., on *Recent Research on Crystalline Structure.*

On Tuesday, January 29, PROF. ARTHUR DENDY, D.Sc., F.R.S., gave a lecture on *What is Heredity*

On Thursday, January 31, MR. WALTER SICKERT gave a lecture on *Straws from Cumberland Market.* (Lecture III.).

THE PHYSICAL SOCIETY.

A meeting was held on Friday, January 25, at the Imperial College of Science, South Kensington, S.W.

A lecture entitled *Recent Work in Stellar Physics* was delivered by E. A. MILNE, M.A., Fellow of Trinity College, Cambridge, and Assistant Director of the Solar Physics Observatory, Cambridge.

The lecture included a review of the relation of stellar spectra to modern spectral theory, with reference to giant and dwarf stars and recent additions to our knowledge of stellar temperatures. Methods of deducing certain atomic quantities from astrophysical evidence were suggested.

THE GEOLOGICAL SOCIETY.

JANUARY 9, PROF. A. C. SEWARD, Sc.D., F.R.S., PRESIDENT, IN THE CHAIR.

The following communications were read and discussed:—

The Geological Structure of the Clevedon-Portishead Area (Somerset), by PROF. SIDNEY HUGH REYNOLDS, M.A., Sc.D., F.G.S., and EDWARD GREENLY, D.Sc., F.G.S.

The Avonian of the Tytherington-Tortworth-Wickmar Ridge (Gloucestershire), by FREDERICK STRETTON WALLIS, PH.D., F.G.S.

The Avonian of the Western Mendips, from the Cheddar-Valley Railway to the Sea, west of Bream Down, by MISS AGNES ELIZABETH BAMBER, M.Sc. Communicated by Prof. S. H. Reynolds, M.A., Sc.D., F.G.S.

A meeting was also held on Wednesday, January 23, when the following communications were read:—

On a Hybodont Shark (Tristychius) from the Calciferous Sandstone Series of Eskdale (Dumfries-shire), by DR. A. S. WOODWARD, F.R.S., F.L.S., F.G.S.

On a Recently Discovered Breccia-Bed underlying Neshells (Birmingham), and its Relations to the Red Rocks of the District, by PROF. W. S. BOULTON, D.Sc., F.G.S.

MINERALOGICAL SOCIETY.

JANUARY 15, DR. A. E. H. TUTTON, F.R.S., IN THE CHAIR.

Papers read:—

A. F. HALLIMOND, *The Chemical Classification of the Mica Group.*

Muscovite and phengite can be represented as mixtures of the molecules, $K_2O.3Al_2O_3.6SiO_2$.aq., and $K_2O.(Fe, Mg)O.2Al_2O_3.6SiO_2$,aq., the amount of water being somewhat variable. The best-known lithia micas are represented as follows:—Lepidolite, $K_2O.Li_2O.2Al_2O_3.6SiO_2$. aq.; Cryophyllite, $K_2O.Li_2O.$ (Fe, Mg) $O.Al_2O_3.6SiO_2$. aq.; Polylithionite, $K_2O.2Li_2O.R_2O_3.6SiO_2$. aq. In the same way the dark micas can be represented as mixtures of phlogopite, $K_2O.6$ (Mg, Fe) $O.Al_2O_3.6SiO_2$.aq., and two biotite types, namely, $K_2O.4$ (Fe, Mg) $O.2Al_2O_3.6SiO_2$. aq., and $K_2O.6$(Fe, Mg) $O.2Al_2O_3.6SiO_2$. aq. In the most acid biotites (from granite) the Al_2O_3 is somewhat greater, with a corresponding replacement of (Fe, Mg) O. Al_2O_3 is, of course, often replaced by Fe_2O_3 $(OH)_2$, by F_2, etc. Graphical formulæ of oxidic compounds (salts) can be simplified by writing the connecting group—O—as a single symbol. The above empirical formulæ can be represented as salts of the single-chain hexa-silicic acid with K, Mg, Fe, etc., and with a diacid alumina group, $Al_2(OH)_2O$, in which hydroxyl is replaceable by fluorine. The greater acidity of the white micas is accounted for by the presence of three acid groups—Si:O:Si—in the chain; biotite results from the addition of 3(Fe,Mg)O to these groups, to form a normal salt; the most basic dark micas contain $Al_2(OH)_2O_2R$ in place of the simple group $Al_2(OH)_2O$, the aluminium becoming "amphoteric" when the solution is very rich in (Fe,Mg)O.

A. BRAMMALL and H. F. HARWOOD, *Gold and Silver as Accessory Minerals in the Dartmoor Granite.*

Visible gold occurs as scanty minute specks in a porphyritic oligoclase-quartz-orthoclase rock containing a pale green fibrous amphibole and abundant sphene, together with apatite, zircon, monazite and, occasionally, tourmaline. The silver has not been observed in hand specimens; assays show that it is usually in excess of the gold. The rock occurs as large loose boulders on Bittleford Down and at a few other localities.

ARTHUR RUSSELL, *Topaz from Cornwall, with an Account of the Localities, Old and New, at which it is found.*

All the hitherto recorded occurrences of topaz in Cornwall are described, as also new ones at Castle-an-Dinas Wolfram Mine, St. Columb Major; Belowda Beacon Mine, Roche; Beam Mine, St. Austell; and Mulberry Mine, Lanivet. Crystals from most of the localities were measured and drawings are given with lists of forms. It is shown that at several localities topaz is present in considerable quantities in the cassiterite-wolfram lodes; at Belowda it is especially abundant with tourmaline.

On Wednesday, January 16, Mr. A. Chaston Chapman, F.R.S., F.I.C., F.C.S., the Council's nominee, was unanimously elected President of the Royal Microscopical Society in place of Prof. Cheshire, O.B.E., F.Inst.P., retiring.

THE INSTITUTION OF ELECTRICAL ENGINEERS.

An Ordinary Meeting was held on Thursday, January 31. A paper entitled *Some Researches on the Safe Uses of Electricity in Coal Mines* was given by Prof. W. M. Thornton, O.B.E., D.Sc.

The Wireless Section held a meeting on Wednesday, February 6. A paper entitled *Atmospherics and their Effect on Wireless Receivers*, was read by E. B. Moullin, M.A., Associate Member.

EMPIRE MINING AND METALLURGICAL CONGRESS.

This Congress will be held at the British Empire Exhibition, on June 3, 4, 5, and 6.

The Viscount Long of Wraxall, President, will preside over the main sessions.

The President will deliver "The Sir Julius Wernher Memorial Lecture," and he will take as his subject "Mineral Resources and their Relation to the Prosperity and Development of the Empire."

The papers accepted for discussion will then be presented and remitted for discussion by the appropriate sections.

The opening session on June 3 will adjourn about 1 o'clock p.m., and after the luncheon interval, official visits will be paid to the mineral exhibits of the Dominions, India, and the Crown Colonies, and to the model colliery and coal-mining industry exhibit organised and erected by the Mining Association of Great Britain, with the co-operation of representatives of the Institution of Minng Engineers, the Miners' Federation of Great Britain, and the Mines Department of the Board of Trade.

The several sections will meet in the conference halls allocated to them on June 4 and 5, for the reading and discussion of papers.

In the evening of June 4, the "May Lecture" of the Institute of Metals will be delivered by Dr. F. W. Aston, F.R.S., whose subject will be "Atoms and Isotopes."

CORRESPONDENCE.

A SCHEME OF COLOUR BRIGHTNESS.

To the Editors of The Chemical News.

Sirs,—Brightness and penetration are necessary definitions in applying measurement to a successful scheme to secure uniformity of colour in paint and varnish.

By uniformity it is implied that they conform to a satisfactory appearance on viewing them together.

Measurement of the distance at which a given colour fades to vanishing point in obscure light, and, taken for a series of colours doing this it would give a proportionality of their brightness when viewed at the same distance, from which the degree of brightness could be taken as a factor to calculate the distance at which they would give uniform appearance.—Yours, &c.,

J. C. Thomlinson, B.Sc.

TRADE IN RUSSIA.

To the Editors of The Chemical News.

Sirs,—Legislation permitting the patenting of inventions in Russia under the new regime is now in a fair way to being consummated, and the registration of trade marks may, it is hoped, after reciprocal treaties have been concluded, follow subsequently.

British patentees and manufacturers are advised to be early in the field to secure priority and thus protect their rights against infringement. The possession of a patent or trade mark is not only a valuable asset to a business goodwill, but early protection is a necessary forerunner to the opening up of trade relations and the safeguarding of industrial rights therein.

We shall be pleased to furnish further particulars on application.—Yours, &c.,

King's Patent Agency, Ltd.

146a, *Queen Victoria Street,*
London, E.C.4.
January 18, 1924.

NOTICES OF BOOKS.

Quantitative Chemical Analysis, by FRANK CLOWES, D.Sc. (LOND.), and J. BERNARD COLEMAN, A.R.C.Sc. (DUBLIN). Pp. XXIV. + 576. Twelfth Edition. 1924. London: Messrs. J. & A. Churchill, 7, Great Marlborough Street, W.1. 18s. net.

It is a melancholy coincidence that the appearance of the twelfth edition of this well-known textbook should be almost simultaneous with the death of Prof. Clowes.

Prof. Clowes was engaged in the teaching of chemistry for many years at the University of Nottingham. During this period he and his collaborator, Prof. Coleman, produced their "Quantitative Chemical Analysis," which has, since then, run through so many editions.

It has enlarged its scope and usefulness from being merely a students' laboratory manual, and is now a work of reference, being consulted by analysts and works chemists.

Parts I., II. and III., dealing with general processes, simple gravimetric estimations, and volumetric analysis, constitute a straightforward course for the student. Part IV. is more general, and includes such technical analyses as those of alloys and ores, alkali valuations, and a section on the examination of oils, fats, and waxes. Part V. consists of exercises in organic analysis and molecular weight determinations, suitable for the advanced student. Part VI. deals with the analysis of gases. The reference tables of constants, etc., are included in Part VII., which is followed by a section (Part VIII.) on the preparation of gases and the use of compressed gases.

Typical results are given for the technical analyses. It will thus be seen that the book constitutes a valuable addition to the analyst's library as well as being a standard textbook.

Smith's General Chemistry for Colleges, Revised and re-written by PROF. JAMES KENDALL. Pp. XIII. + 747 + 8 plates. 1923. London: G. Bell & Sons, Ltd., York House, Portugal St., W.C.2. 10s. 6d.

Prof. Kendall's revised edition of Alexander Smith's *General Chemistry* has brought this important textbook up-to-date. The book is obviously that of a teacher whose object must be to impart the groundwork of the science in the student's mind. Hence it is essentially definite and dogmatic, even in cases where, admittedly, two explanations are equally admissible.

When the student has fully grasped the principles of chemistry, *i.e.*, after he has passed the *Intermediate* stage, it is time to draw attention to certain cases of doubt, previously ignored. It is on this basis that some of the sweeping generalisations of the book are justifiable.

A very wide field is covered, and many applications of chemistry to other sciences and to industry in peace and war are described, frequently with very attractive illustrations. Some of the diagrams, however, could be better. This is noticeably so in the case of the distillation apparatus on p. 82 and the apparatus used for preparing bromine (p. 271).

Modern theories on atomic structure are briefly considered in a manner suitable for students.

The book will certainly be popular among both teachers and pupils.

J.G.F.D.

General Chemistry—An Elementary Survey, by HORACE G. DEMING, Professor of Chemistry, University of Nebraska. Pp. XII. + 605. 1923. London: Messrs. Chapman & Hall, 11, Henrietta Street, Covent Garden, W.C.2. 17s. 6d. net.

Courses in chemistry differ widely in scope. Thus, there are not only the schemes of studies of the various branches of the science pursued in the universities, but there are also many and varied courses followed in technical institutes.

Frequently the latter are concerned with the relation of chemistry to industry. Prof. Deming has presented, in a unique way, an elementary survey of the general principles of chemistry, at the same time emphasising the connection between the science and its industrial applications. His book is therefore useful as a guide, and is adaptable to many requirements. General principles are presented as entities, and there has been no attempt to give a complete description of individual substances. Indeed compounds of purely theoretical interest have been omitted, and the space thus saved has

been given to a more complete account of the principles and applications, for example, that of the study of hydrogen ion concentration, and of the colloidal state.

The book is freely illustrated, and has been made very attractive for the reader.

Organische Chemie, von DR. R. PUMMERER. Pp. XII. + 210. Zweite vermehrte und verbesserte Auflage. Dresden: Verlag von Theodor Steinkopff, Residenzstr. 12b, Blasewitz. 1923. Price 4s.

Prof. Pummerer's volume on Organic Chemistry (Vol. III. of the series on *Researches in Natural Science*, published under the general editorship of Prof. Liesegang), has deservedly reached its second edition.

It deals with the recent advances in many branches of theoretical organic chemistry during the past decade or so.

The first section on Valency Problems commences with a detailed account of the organo-metallic compounds, a subject which has again obtained prominence. It also includes a discussion on Radicles, Thermochemistry, Spectroscopy, and the Keto-enol isomerism.

Recent researches on coal-tar products, sugars, the anthocyanins, chlorophyll, plant assimilation, &c., are recorded and discussed in the subsequent sections.

J.G.F.D.

Molekulargrössen von Elektrolyten in Nichtwasserigen Lösungmitteln, von DR. PAUL WALDEN, Ord. Prof. an der Universität Rostock. Pp. XI. + 350. Dresden & Leipzig: Verlagsbuchhandlung Theodor Steinkopff. 1923. Price 10s.

Elektrochemie Nichtwasseriger Lösungen, von DR. PAUL WALDEN. Pp. XI. + 515. Leipzig: Verlag von J. A. Barth, Dorienstrasse 16. 1924. Price 24s.

Prof. Walden has dedicated his first work to Prof. Beckmann, who introduced the freezing-point and boiling-point apparatus for the determination of molecular weights, and his second book to Prof. Wilhelm Ostwald, on the occasion of their 70th anniversaries. (Prof. Beckmann only survived his by a few days.)

The author has carried out very extensive and exhaustive researches in the field of solutions in non-aqueous media, and these two volumes embody much of his work and that of other investigators in this subject. He has thus rendered good service to chemical science by collecting such data as are contained in these volumes.

The first gives an account of the present state of knowledge regarding Polymerisation, Association, and Complex Formations among acids, bases and salts. He deals with the various phases of these phenomena in connection with solvents and solutes. The apparent molecular weight of electrolytes is discussed very fully.

The second book, though larger, is more restricted in scope. It includes a complete account of the conductivity of pure solvents, of organic and inorganic solutions, the effect of changes in temperature, viscosity, etc.

The extent of the author's own contributions to the subject may be judged by the large number of references to it which are given in the indexes.

BOOKS RECEIVED.

What Industry owes to Chemical Science, by R. B. PILCHER, O.B.E., and F. BUTLER JONES, B.A. (CANTAB.), A.I.C. Pp. XV. + 158. 2nd Edition, 1923. Messrs. Constable & Co., Ltd., 10-12, Orange Street, W.C.2. 6s. net.

PUBLICATIONS RECEIVED.

The Ministry of Agriculture and Fisheries has issued a leaflet, No. 320, on the Manuring of Vegetable Crops. It is pointed out that of the chief food ingredients required by plants, only three have to be applied directly in the form of manure, viz., nitrogen, phosphates and potash. Dung contains all three, but artificial fertilisers usually contain only one or two of these ingredients. Lime is another necessary substance, but it is required not so much as a plant food but because it neutralises any soil acidity, or, in other words, prevents the soil becoming sour, and so checks the development of such diseases of plants as club-root.

Dung from stables, cow boxes or pig sties is still the chief means of securing fertility in the soil. Heavy land is improved in quality by annual dressings of strawy dung, and light soils are rendered more compact and retentive of moisture by short, well-rotted dung.

Poultry and Pigeon Manure is valuable for allotment, but in order to avoid waste this manure should be stored with an equal amount of dry soil in alternate layers, and kept in a convenient receptacle or in a heap in a dry shed until required.

Soot is chiefly valuable on account of the nitrogen it contains, but it also improves the working qualities of the soil. When used as manure, soot should never be mixed with lime, or the ammonia in the soot will be liberated. Six cwt. of good soot are equivalent to about 1 cwt. of sulphate of ammonia.

When waste vegetable refuse is burnt, the ashes should be stored in a dry place until required, as the soluble ingredients are readily washed out by rain. Wood ashes are valuable on account of the potash they contain.

Lime is most valuable on heavy clayey soils, and other soils infected with the club-root fungus. It may be applied either in autumn or early spring, but it should not be put on at the same time as dung. It is best to do the digging and manuring in the autumn or early winter, and to apply the lime in a dry slaked form about the beginning of March. Good ground lime (containing 90 per cent. quick-lime, CaO) should be used when possible.

The most suitable of the artificial fertilisers are sulphate of ammonia, sulphate of potash, basic slag, bone meal and fish guano; the last-named is perhaps the most valuable manure the small cultivator can have. The use of superphosphate is sometimes recommended, but is not advisable on small areas where much of the crop rotation will take the form of Brassicæ (cabbage family), and it is better to substitute basic slag or bone meal for it.

As in the case of lime, artificial manures should be applied on the surface after digging or ploughing has been completed, with the exception of some of the more readily available fertilisers used as a top dressing at the time of planting or later.

The U.S. Department of the Interior, Bureau of Mines, has issued the following bulletins:—

Smoke Abatement, by OSBORN MONNETT. Pp. IV. + 31.

Tests of a Powdered-Coal Plant, by HENRY KREISINGER, JOHN BLIZARD, C. E. AUGUSTINE and B. J. CROSS. Pp. IV. + 22.

Coke-Oven Accidents in the United States, by WILLIAM W. ADAMS. Pp. 37.

Erection of Barricades during Mine Fires or After Explosions, by J. W. PAUL, B. O. PICKARD and M. W. VON BERNEWITZ. Pp. IV. + 28.

Bibliography of Petroleum and Allied Substances, 1921, by E. H. BURROUGHS. Pp. XII. + 230.

Manual for Oil and Gas Operations, by T. E. SWIGART and C. E. BEECHER. Pp. IX. + 145.

Certain Interfacial Tension Equilibria Important in Flotation, by WILL H. COGHILL and CARL O. ANDERSON. Pp. VI. + 55.

Efficiencies in the Use of Bituminous Coking Coal as Water-Gas Generator Fuel, by W. W. ODELL. Pp. IV. + 39.

Change Houses in the Lake Superior Region, by CLEVE E. KINDALL. Pp. IV. + 29.

Methods of Decreasing Evaporation Losses of Petroleum, by J. H. WIGGINS. Pp. VI. + 57.

PHYSICS IN INDUSTRY.

The sixth of the series of public lectures on this subject, being delivered under the auspices of the Institute of Physics, will be given by Dr. C. H. Desch, F.R.S., Professor of Metallurgy in Sheffield University. The subject will be "The Physicist in Metallurgy," and the lecture, which will be illustrated, will be given in the rooms of the Chemical Society, Burlington House, Piccadilly, W., on Wednesday, February 6, at 5.30 p.m.

Sir Charles Parsons, President of the Institute, will preside.

New Patents.

This list is specially compiled for *The Chemical News* by Messrs. Rayner & Co., Registered Patent Agents, of 5, Chancery Lane, London, from whom all information relating to Patents, Trade Marks, and Designs can be obtained gratuitously.

Latest Patent Applications.

842—Fabriques de Produits Chimiques des Thann et de Mulhouse.—Production of cyanides and their derivatives from alkali-earth cyanamides. Jan. 11.

884—*Deutsche Gold und Silber Scheide Anstalt* vorm., Rossler.—Manufacture of sodium perborate. Jan. 11.

874—Deutsche Celluloid Fabrik.—Process of recovering nitric acid from weak nitric liquors. Jan. 11.

Specifications Published this Week.

208764—Mehner, Dr. H.—Process for the production of zinc in reverberatory furnaces.

208972—Soc. of Chemical Industry in Basle.—Process for improving dyeings obtained with sulphur dyestuffs.

208760—Badische Anilin & Soda Fabrik.—Means for electrically heating gases under pressure for use in catalytic production of ammonia.

208761—H. Goldschmidt (deceased) and Neuss, O.—Manufacture of condensation products of formaldehyde and carbonate derivatives.

Abstract Published this Week.

207267—Treating liquids with chemical reagents.—Paterson, W., of Windsor House, Kingsway, London.

Relates to the treatment of liquids with chemical reagents by apparatus in which the flow of liquid is measured by a weir, Venturi meter, or otherwise, and consists in utilising such means to control electric means directly or indirectly effecting the addition of the reagent in proportion to the rate of flow of the liquid. The invention also consists in the provision of means for varying the rate of addition of the reagent with or without interfering with the continuous operation of the apparatus.

Messrs. Rayner & Co. will obtain printed copies of the published specifications and abstract only, and forward on post free for the price of 1s. 6d. each.

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THE CHEMICAL NEWS,

VOL. CXXVIII. No. 3330.

ARE THE NATURAL GROUPINGS OF THE ELEMENTS AND THE SPECTRAL LINES OF HYDROGEN RELATED?

PART XII.—ERRATA AND ADDENDA.

BY F. H. LORING.

(*Concluded from Page 54.*)

Referring to *The Chemical News* of January 25, 1924, on page 50, in the tabulation, the N″ values for Ganymede and Callisto should be bracketted. Similarly, values 174 and 221 should be bracketted. The bracket for the N″ values of Mimas and Enceladus should embrace both figures.

In the *Corrections* on page 50, "1.25" should read "3.25." On page 52, 2nd column, 13th line from bottom of page, "is" should read "are"—but this is a minor detail.

Referring to page 52, upper table in column 2, the left-hand summation is as indicated when the division is carried out further in the decimal places than shown.

Referring to the N′ and N″ values in the tabulations, where two or three satellites are bracketted, it is evident that to appreciate the significance of the relations shown, the ideal values, 48, 21, &c., represent the *middle* of circular (or elliptical) roads in space, and where two or three satellites travel, so to speak, on one road, they cannot take the middle course, but must adjust their positions so as to be approximately symmetrical therein. Perfect satellite symmetry, however, is not to be expected, on account of perturbing influences already discussed. Some satellites, therefore, resemble in a remote way doublets and triplets in spectra. This observation adds to the list of close analogies between the spectra of hydrogen and the solar system.

There is a paper on the "Spectral Series and the Groupings of the Asteroids," by F. E. Kester and D. Alter, which appeared in the *Astrophysical Journal*, 1919, Vol. L., p. 50, which is of interest in connection with Part IV. of this series of papers. This paper may be reproduced in condensed form in a subsequent issue of *The Chemical News*, so as to make the treatment fairly complete.

THE STRUCTURE OF NEON AND ARGON.

BY HAWKSWORTH COLLINS.

The only elements of atomic weight less than 41, from which a single electro-positive force is known to emanate, are H(1.008), H_3(3), Li(7), Na(23), and K(39). Although H is the only one of these whose mass (or whose isotopic masses) is not observed to be a whole number, yet, since 7, 23 and 31 (P) are prime numbers, it is evident that the only whole number of which they (except H) can and must all be multiples is 1. This unit will be called H in the following.

(*a*) Split up the atomic weights or the masses of the dominant isotopes, except those of Be(9) and N(14), into as many parts, 1, 3, 7, 23 and 39, as the number of its column in the Periodic Table (taking the zero column as the eighth), and in such a manner that 1 comes in every even place, but never in an odd position; the other *numbers, 3, 7, 23, 39, being arranged* in order of magnitude, starting with the largest on the left (Table I.).

There can be no objection to exceptions, since there is no reason why all elements should be supposed to be built up in the same manner.

If any one of the numbers in the second column had been greater or less by 3 at least, the element it represents would have been an exception. Therefore the probability that any particular one could accidentally be split up in this uniform manner is 1 : 7. There are 19 elements in Table I. Take away the 5 which are represented by 1, 3, 7, 23 and 39, and add the two exceptions, Be and N. There are then 16 to be considered. The probability that there would be no exceptions is 1 : 7^{16}. With two exceptions the probability that this state of affairs has happened by accident is

$$7 : 7^{16} - \frac{2 \times 7}{6} = 1 : 7^{13 \cdot 6} = 1 : \text{billions.}$$

Therefore the probability that this method of splitting up the atomic weights of the simple elements contains a truth is billions to one; *i.e.*, it is absolutely certain that it contains a truth. But the probability that it does so is much greater than this from the following considerations: In the case of Al(27) no other number between 16 and 39 inclusive can be split up in this manner

into three parts. A similar remark can be made in 6 cases out of 14, the corresponding numbers being given in column 8.

Even without the "probability" proof it is quite evident that the atomic weights of these elements (which happen to include nearly all the common ones) are peculiar in that they can be split up in this way.

A simpler demonstration that the matter contains a truth is as follows:—If all the atomic weights of the 21 elements as far as Ca, including Be and N, were smaller than they are by unity, not one of them could be split up in this manner; and if they were all one unit larger, only N could be thus split up. Therefore, the property is peculiar to the particular numbers which are known to be the atomic weights.

Now that it has been proved that the table contains a truth, it is correct to take it as it is (Be and N having now nothing to do with it), and see whether it contains any other truths.

(*b*) Whenever there is a portion (1 + 3) or (3 + 1), (Helium), the element is non-metallic, and when there are no such portions the element is metallic. The probability that this state of affairs would happen by accident is $1 : 2^{19} = 1 : 500,000$, as there is no exception, H being classed as a metal as usual.

In consequence of this, the helium portion or portions will be called the non-metallic part of the element, and the remainder the metallic portion; *e.g.*, in sulphur the parts 23 + 1 are called the metallic portion, and the (3 + 1) + (3 + 1) the non-metallic.

(*c*) The only elements, the sum of whose metallic portions is not greater than the sum of the non-metallic portions, are He, O, F and Ne.

(*d*) Single electro-negative valences emanate only from each of the parts, 1, 3, 7, 23, 39, of the metallic portions of non-metallic elements, whilst electro-positive valences emanate from all other portions; but when the mass of the metallic portion of the element is not greater than the mass of the non-metallic portion, then the electro-positive valences are all quiescent; *e.g.*, in F the six electro-positive forces are quiescent, leaving only the single electro negative valence. The only exceptions to this observation are Neon and Argon. The probability that this contains a truth is $2^{19-2\times2} : 1 = 32,000 : 1$. The above means that the maximum number of electro-positive and negative valences that are

known to emanate from each element, is exactly explained by this method of splitting up their atomic weights, except in the cases of Ne and A.

(*e*) The cause of the atomic numbers of the elements from H to Ca is made plain by Table I.; for those of H, He, Li, Na and K are known to be 1, 2, 3, 11, and 19 respectively; and as that of He is 2 and H 1, therefore that of H_3 must be 1. Taking S as an example, 11 + 1 + 1 + 1 + 1 + 1 = 16. The probability that this contains a truth is $2^{19-2} : 1 = 130,000 : 1$, as Argon is the only exception.

The cause of the atomic numbers of Li, Na and K is also evident from the ultimate constitution of the elements (*C.N.*, December 19, 1919). If 7, 35 and 39 be split up by putting ones in the even places and threes in the odd places, the number of parts into which the atomic weight of each is divided is equal to the corresponding atomic number. It follows from this that when H_3 forms part of an element, two of its atomic units have entirely lost their positive charges.

(*f*) The longer the string of helium portions, the stronger (*ceteris paribus*) are the electro-negative forces, except Ne and A.

(*g*) The longer the same string (*ceteris paribus*), the more volatile is the element, except argon.

(*e*) is an exact observation, (*f*) and (*g*) may be called rational observations.

Since it has been proved that, if the atomic weights of the simplest elements be split up in the manner of (*a*), there are then observable three other sets of coincidences (*b*), (*d*), and (*e*), which could not have happened by accident, the truth must have been obtained; and since Neon and Argon are exceptions to some of these, it is obviously correct to take all known facts (including those which have been deduced above) with regard to these elements, in order to find out why they are exceptions.

The International Committee give 20 and 22 as the masses of the isotopes of Ne, and 40, 36 as those of Argon. If an atom of Neon is formed in the atmosphere by a flash of lightning (in a similar way to that in which Collie and Patterson formed it) causing the union of one of helium with one of oxygen in the manner shown in Table I., it would have two very strong electro-negative forces emanating from the portion Li—H, not necessarily equal, because one would be supported by a mass of 7, and the other by a mass of 1; so that one may be

considered to be electro-positive in relation to the other, as in the known case of the two electro-negative valences of oxygen. If these forces as so strong (*f*) that they cannot exist for more than a moment, they would either combine with one another and form the inert element Neon (20), or two of the newly formed atoms would unite, the lithium portion of one with the H portion of the other, and form an atom of Argon (40); or, if a molecule of H_2O is sufficiently near before this can happen, NeH_2 (22) and NeO (36) might be formed, both exceedingly stable.

If the spectrum of 20 and 22 were examined, nothing but Ne and H would appear; and if that of 40 and 36 were examined, A, Ne and O would appear, and chemists would come to the conclusion that the Argon had not been completely separated from Ne and O, and they would therefore decide that 40 and 36 have the same spectrum.

As Argon has a distinct spectrum, since it is an element and not Ne_2, the forces which are not chemically evident, and which bind the parts of an atom, must have also come into play (*C.N.*, January 16. 1914).

If this is correct, being a logical interpretation of all known numerical facts concerning Neon and Argon, then the constitution and structure of these two elements must be as given in Table II., where the thick lines denote valences, and the thin lines represent the atomising bonds.

These formulæ explain why the two elements are exceptions to (*d*), also why Argon was split up wrongly in (*a*), and why the two are exceptions to (*f*), also why Argon is no longer an exception to (*g*); but it does not explain why the atomic number of Argon should have been found by direct experiment to be 18 instead of 20.

It is not long since Prof. Soddy said that "if a new element between H and Al were discovered, it would be necessary to alter the whole of the subsequent atomic numbers to correspond," so that the direct experimental method does not seem to be yet very exact.

TABLE I.

1	2	3	4	5	6	7	8
Element	At. wt. or mass of dominant isotope	Atomic weights split up	Atomic No. as usually given	No. of parts into which at.wt.is divided	Column of Periodic Table	Max. Valency	
H	1	1	1	1	1	1	
H_3	3	3	1	1	1	1	
He	4	3+1	2	2	2	2	1 - 7
Li	7	7	3	1	1	1	
B	11	7+1+3	5	3	3	3	8 - 14
C	12	7+1+3+1	6	4	4	4	9 - 15
O	16	7+1+3+1+3+1	8	6	6	2	13 - 19
F	19	7+1+3+1+3+1+3	9	7	7	1	16 - 22
Ne	20	7+1+3+1+3+1+3+1	10	8	8	0	17 - 23
Na	23	23	11	1	1	1	
Mg	24	23+1	12	2	2	2	9 - 39
Al	27	23+1+3	13	3	3	3	16 - 30
Si	28	23+1+3+1	14	4	4	4	17 - 31
P	31	23+1+3+1+3	15	5	5	5	24 - 34
S	32	23+1+3+1+3+1	16	6	6	6	25 - 35
Cl	35	23+1+3+1+3+1+3	17	7	7	7	32 - 38
A	40	23+1+7+1+3+1+3+1	18	8	8	0	37 - 43
K	39	39	19	1	1	1	
Ca	40	39+1	20	2	2	2	25 - 43

Helium is here considered as being either in the second, or zero, column of the Periodic Table, as it is sometimes said to have two valences and at other times none.

TABLE II.

$$Ne = Li—H—H_3—H—H_3—H—H_3—H$$
$$H—H_3—H—H_3—H—H_3—H—Li$$

AN EXPLANATION OF THE THEORY OF THE ROTATION OF THE ATOMIC NUCLEUS.

PART V.

By HERBERT HENSTOCK.

OXIDES.—(*Continued*).

Group VI.

Ozone is depicted in Fig. 1.

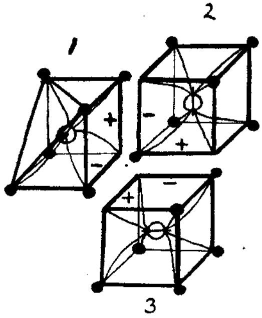
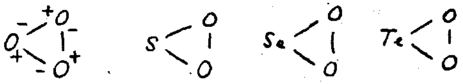


Fig. 1.

Each atom has both positive and negative bonds coming into play. These bonds will therefore be weak ones, and the molecule will be unstable (rule 2). Atom No. 1 will be the active one, which will break away when the molecule disrupts, 2 and 3 will then close up forming a double bond.

General types, SO_2, SeO_2, TeO_2, etc., may be looked upon either as constituted similarly to ozone:



in which the sulphur, selenium or tellurium would be in the position of the No. 1 oxygen atom in ozone, or as having the constitution Fig. 2.

O=S=O, O=Se=O, O=Te=O, shown in

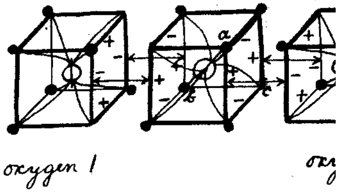
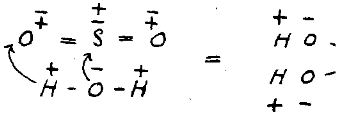


Fig. 2.

There are two electrons at both a and b, so that these bonds are weak; the substances are therefore attacked by such a weak reagent as water:



One oxygen atom forms a single bond with the sulphur, and the hydrogen of the water attaches itself to this oxygen, both oxygen bonds being normal negative ones: an electron in the sulphur atom moves from b to c, and oxygen atom No. 2 turns over on to the top of the sulphur octet. Thus:

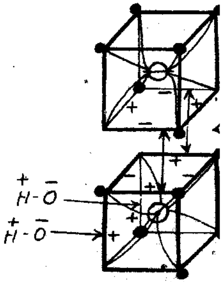


Fig. 3.

Sulphur tri oxide will be as shown in Fig. 4.

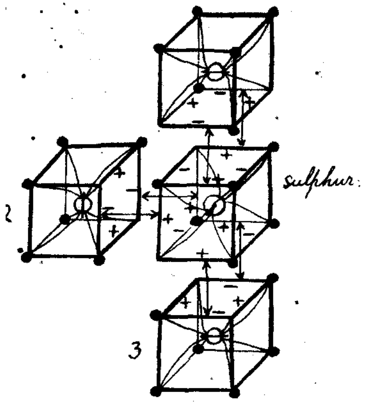
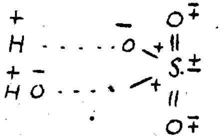


Fig. 4.

All the oxygen atoms are united to the sulphur by double bonds.

Sulphuric acid is formed by No. 2 oxygen atom breaking the double bond and forming a single one with one of the positive single ones of the sulphur, the OH group joining the remaining single bond left free: as



All oxy acids formed from anhydrides may be represented somewhat similarly.

The extra electrons over and above the octets, where two electrons occur at one corner, may be driven inside the atoms to form incomplete inner rings of electrons.

Oxy Compounds.

Such substances as NOCl, $POCl_3$, etc., have irregular compositions; the case of $POCl_3$ is typical, and is shown in Fig. 5.

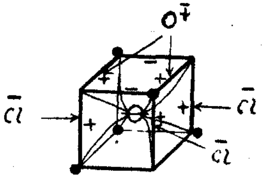
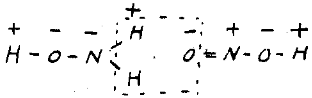


Fig. 5.

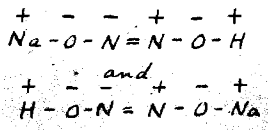
Positive single bonds, together with the negative bonds of the double bond, occur in the same atom; the phosphorus would naturally unite by its negative edges, and not by its positive ones (*vide* the case of NCl_3, Part II.), hence the instability.

Reactions.

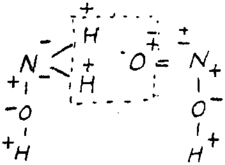
Many reactions may be better understood if the *bonds*, instead of the atoms, are labelled; as an example, the formation of hypo-nitrous acid from nitrous acid and hydroxylamine. If the atoms are labelled completely positive or negative we have:



The polarities for the reaction are here correctly expressed, since positive hydrogen unites with negative oxygen to form a molecule of water, and positive nitrogen unites with negative nitrogen to form hyponitrous acid, but we are faced with negative oxygen united with negative nitrogen in both hydroxylamine and hyponitrous acid, in the latter of which the OH group attached to negative nitrogen should differ in its properties from that attached to positive nitrogen, thus giving two series of salts of the types:

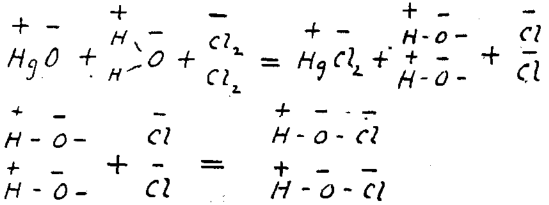


but we have no evidence that salts of such a nature exist. When the correct polarities are prefixed we are not faced with such a difficulty:

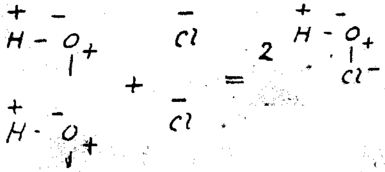


Here it must be remembered that when the double bond is broken, the oxygen can have two negative single bonds and *per contra* the two negative single bonds of the nitrogen can become the $\pm$ of the double bond. (*See description of the double bond, Part III.*)

Again, in the formation of hypochlorous acid from HgO, water and chlorine, if we write in the usual fashion



the equation being divided into two parts in order to show the course of the reaction; we have negative oxygen uniting with negative chlorine; if, however, we write equation (2) as



the true significance of which may be seen, on drawing out the octets and putting in the lines of force and correct polarities, no such difficulty appears; also the formula of hypochlorous acid expressed in equation (3) shows that it is an unstable substance, whereas this is not shown in (2).

Another instance is that of the ammonium salts: the reaction expressed as

$$\overset{+\,-}{H_3N} + \overset{+\,-}{HCl} = \overset{+\,-\,+\,-}{H_3N\ HCl} \text{ or } (\overset{+\,-\,-\,-}{H_4NCl})$$

does not correctly indicate the facts (see Part II.), since nitrogen is positive in these salts and the hydrogen of the acid is negative; as

$$\overset{+\,-}{H_3N} + \overset{+\,-}{HCl} = \overset{-}{H_3} = \overset{+}{N} - \overset{-}{H} + \underset{Cl-}{} \text{ or } [\overset{-}{H_3} = \overset{+}{N} - \overset{-}{H}]\overset{+\,-}{Cl}.$$

From all that precedes, therefore, the following generalisations may be laid down, viz.:—

(1) "When two or more atoms unite, the bonds uniting them are of opposite polarities in each atom."

(2) "Normal stable compounds are formed only where each atom is united to its neighbours by single bonds, which are all positive or all negative throughout each atom." Such bonds are those by which an atom normally and usually unites; *i.e.*, positive bonds in an atom of positive permanent polarity and negative in an atom of negative permanent polarity.

(3) "Normal stable compounds are formed only where atoms are united by double or treble bonds, which have positive and negative bonds corresponding in each atom, which may be in conjunction with single bonds normal to each atom."

(4) "Neutral atoms, like carbon, may unite normally by either positive or nega-

tive bonds, but the tendency will be for those compounds to be the more stable where bonds are all of one polarity in each atom."

Examples of the application of the theory of nuclear rotation might be multiplied indefinitely, but enough has been given to show its general applicability over the whole of inorganic chemistry, and that many anomalous cases, as well as the construction of many substances, hitherto unexplained, may be elucidated by its means.

The assumption, that the nucleus is di polar and that it may rotate through angles of 90°, is of course a problem, which only future physical and mathematical discoveries will elucidate. Sir Robert Robertson has kindly drawn my attention to a piece of evidence, which already exists, to show that this view may be the correct one; this will be found in the experiments of Stern and Gerlack (*Z. Physik.*, 1921, VII., 85; 1922, IX., 345 and 353); see also W. Gerlack (*Physica*, 1922, II., 122), who projected atomic silver through a non-uniform magnetic field on to a glass plate, and found that there were two spots of silver on the plate instead of one. This deflection they found to be due to the atom of silver possessing a magnetic moment, which sets itself parallel to or anti-parallel to the magnetic field, *i.e.*, the two moments are at right angles to one another. If this is the case with the silver atom, it is very probable that the same thing will be found to hold with the atoms of other elements.

Chemical Research Laboratory,
School Gardens,
Shrewsbury.

STUDIES IN THE REACTIONS OF THE AMINO GROUP IN 4' AMINO 1 PHENYL 5 METHYLBENZOTHIAZOLE.

PART III.—THE ISOLATION OF THE QUINOLINE OF DEHYDROTHIOPARATOLUIDINE.

BY R. F. HUNTER, F.C.S.

(*Continued from Page 67.*)

4' Amino 1 phenyl 5 methylbenzothiazole or dehydrothioparatoluidine (1) should be capable of yielding a quinoline (2) by Skraup's reaction, that is to say, by heating with a mixture of sulphuric acid, glycerol, and arsenic acid.

$$CH_3C_6H_3 \left\langle {S \atop N} \right\rangle C\ C_6H_4NH_2$$

(1)

$$CH_3C_6H_3 \left\langle {S \atop N} \right\rangle C\ C_9H_8N.$$

(2)

Assuming the usual course of reaction, that is to say, the production of acrolein, the combination of this with the amino compound, and assuming the elimination of water from the aldehyde and base, followed by the direct removal of two hydrogen atoms by the reduction of the arsenic acid, the structure of the quinoline will be (2). The odour of the quinoline will clearly be modified by the presence of the thiazole ring in the molecule, that is to say, if the thiazole ring acts as an odorophore. There appears to be some doubt as to whether the thiazole ring does indeed act as such, since Meyer (*loc. cit.*) found that of the large number of the benzothiazoles which he examined in the course of his research only seven of the compounds examined had characteristic odours. It would appear, in fact, that the odour of these compounds is associated with the presence of the tertiary nitrogen atom, for instance, although phenyl benzothiazole has a characteristic odour reminiscent of tea roses, the substitution product, dehydrothiotoluidine, is odourless in the pure condition (M.P. 191), while in the quinoline (2) described in this paper, where we have a pyridine ring, we again have a tobacco-like odour.

The compound (2) has been previously prepared by Meyer, who found that the compound added methyl iodide in the usual manner. The preparation was repeated in a modified form as described in this paper, the quinoline was found to exhibit the fine fluorescence which is characteristic of this class of fused homocyclic five nitrogen sulphur heterocyclic ring systems (see *The Chemical News*, 1923, and *J.S.C.I.*).

EXPERIMENTAL.

Preliminary:

1 gm. of pure dehydrothiotoluidine, prepared by the author's method (*J.S.C.I.*, 1923), 2 ccs. of concentrated sulphuric

acid, 1.5 ccs. of glycerol, and 1 gm. of arsenical acid were heated in a small round-bottomed flask fitted with an air condenser, in an oil bath at 180° C. for two hours. The sepia-coloured product was shaken with 100 ccs. of hot water, and the solution filtered. The solution was of a yellow colour. To the solution was added 5 gms. of solid sodium hydroxide. A dark brown precipitate makes its appearance on neutralization. The liquid exhibited the unpleasant odour associated with compounds of the type of pyridine. The solid was then filtered and well washed, dried, dissolved in hot alcohol to an orange brown solution displaying fluorescence, from which, on concentrating and cooling, microscopic crystals were obtained of a brown colour. To a saturated solution of these in alcohol was added a small quantity of methyl iodide. The tube containing the solution was warmed and cooled, when a fine grey precipitate, assumed to be Meyer's methiodide, separated out.

The preparation of the Quinoline:

4 gm. of dehydrothiotoluidine, 3 gm. of arsenic acid, 5 ccs. of glycerol, and 8 ccs. of concentrated sulphuric acid are mixed in a 500 cc. round-bottomed flask fitted with a short water condenser. The flask is heated for an hour in an oil bath at 180° C. A peculiar odour is observed during the heating, and whitish coloured fumes appear at the top of the condenser, and the liquid shows a tendency to froth considerably. At the end of the heating, 200 ccs. of boiling water are added to the contents of the flask and the flask well shaken. The solution thus obtained is filtered and allowed to cool. 20 gms. of caustic soda in the minimum quantity of water are then added to the filtrate. The beaker containing the filtrate becomes filled with an ochre-coloured precipitate. This, when filtered and washed, is vermilion in colour, and on standing and allowing to dry assumes a brown colour.

The Imperial College of Science and Technology,

South Kensington, S.W.7.

December, 1923.

THE PREPARATION OF DERIVATIVES OF DEHYDROTHIOPARATOLUIDINE

PART I.—NITRODEHYDROTHIOPARATOLUIDINE

By R. F. HUNTER, F.C.S.

Dehydrothioparatoluidine (1), either by direct nitration of its benzal compound or itself yields nitrodehydrothioparatoluidine (2):

$$CH_3C_6H_3 < {}^{S}_{N} > C\ C_6H_4NH_2$$

(1)

$$CH_3(NO_2)C_6H_2 < {}^{S}_{N} > C\ C_6H_4NH_2.$$

(2)

Recently the author used dehydrothiotoluidine and nitrodehydrothiotoluidine for the preparation and examination of certain properties of thiazole dyes. In these preparations, the crude nitro derivative was used directly in a nitric acid bath for diazotization. Nevertheless it was decided to prepare nitrodehydrothiotoluidine in a pure state. The product which is obtained on drowning the solution of the nitro compound in nitric acid in water is not, as supposed at first, the compound (2), but the nitrate of this. Thus, when dehydrothiotoluidine is nitrated in the manner described by the author in Thiazole Dyes, Pt. II., the yield of the nitrate of the nitro compound is nearly theoretical for the equation:

$$CH_3C_6H_3 < {}^{S}_{N} > C\ C_6H_4NH_2 + 2HNO_3 =$$

$$CH_3(NO_2)C_6H_2 < {}^{S}_{N} > C\ C_6H_4NH_2HNO_3 + H_2O.$$

In fact, owing to the extreme insolubility of the nitro compound in water, the yield is really quantitative.

The nitrate of dehydrothiotoluidine was prepared as described, and it was thought to prepare the free amino compound by heating the product with caustic soda solution (2N—). Here something peculiar occurred, for the nitro compound went into

solution, when excess alkali is present. This is peculiar, since the compound does not even contain a hydroxyl group, and there appears to be no way of isomerising (2) to such a hydroxy compound. At this point it was decided to examine the literature of the subject, and a similar instance was found in a paper of Green's (*J.C.S.*, 1889), for Green found that dimethyldehydrothiotoluidine chloride and iodide exhibit the same property, that is, giving complete solution in caustic soda. He suggested that a natroxide is formed, and noted that the compounds were reprecipitated from the alkali solution by acetic and carbonic acids.

In the original experiment, concentrated hydrochloric acid was added to reprecipitate the nitro compound. This yielded a sludgy brown product, which took over a day to filter, rendered clean washing impossible, and the use of hydrochloric acid tends to the production of the hydrochloride. In many cases where caustic soda is difficult to use, it is better to use ammonia. Referring to Green's paper, we find that he uses this reagent for the production of the sulphonic acid of dehydrothiotoluidine. Therefore the dry nitro dehydrothiotoluidine nitrate was boiled into a suspension with water, and strong ammonia added till strong alkalinity was produced. The solution was heated, when complete solution took place; the solution was filtered, and the nitro compound precipitated by the addition of dilute acetic acid, drop by drop. This yields a product easily filtered and washed, and avoids the danger of formation of the hydrochloride of the base. The product was then dried, as a brown solid.

Experimental.

4 gms. of dehydrothiotoluidine are placed in an 80 cc. beaker, and concentrated nitric acid is run in slowly from a burette with steady stirring, till a clear brown solution results. Considerable heat is evolved, and a certain amount of nitrous fumes appear. The beaker is then warmed on a water bath for twenty minutes to complete the reaction. The brown solution is then drowned in 200 ccs. of cold water. A bright orange precipitate results, which is filtered at the pump, washed and dried.

The product thus obtained is boiled into a fine suspension with 300 ccs. of hot water. To this is then added considerable excess of strong ammonia, when first a change of colour and then solution takes place. The solution is then filtered free from any residue. The filtrate is allowed to cool, and dilute acetic acid added drop by drop until no more precipitate forms. The precipitate is filtered and washed with hot water to remove traces of acetate, etc.; then dried on the steam, and finally between blotting paper.

The Imperial College of Science and Technology,

South Kensington, S.W.7.

January, 1924.

RAMSAY MEMORIAL FELLOWSHIPS.

The scheme for Fellowships in Chemical Science, in memory of the late Professor Sir William Ramsay, has now come to full fruition. At the present time sixteen Fellowships for Chemical Science are being held in the universities or colleges of the United Kingdom.

The complete list of awards for the present session is as follows. In each case the university or college, which has been selected by the Fellow for his research, is given.

British Fellowships.—Mr. Samuel Coffey, Ph.D.; University College, London. Mr. R. W. Lunt, Ph.D.; University College, London. Mr. A. F. Titley, B.Sc., Phil.D.; University of Oxford.

Glasgow Fellowships.—Mr. J. A. Mair, B.Sc.; University of Glasgow. Mr. T. S. Stevens, B.Sc.; University of Glasgow.

Canadian Fellowship. — Mr. E. H. Boomer, Ph.D.; University of Cambridge.

Danish Fellowship.—Mr. K. Höjendahl, University of Liverpool.

Dutch Fellowships.—Dr. C. F. van Duin, University of St. Andrews (temporarily absent on account of ill-health). Dr. J. Kalff; University of Liverpool.

French Fellowship. — Dr. H. Weiss; Royal Institution, London.

Greek Fellowship.—Temporarily vacant.

Italian Fellowship.—Dr. A. Nasini; University of Cambridge.

Japanese Fellowship.—Dr. N. Kameyama; University College, London.

Norwegian Fellowship. — Mr. Gunnar Weidemann; University of Cambridge.

Spanish Fellowship.—Dr. Miguel Crespi; University College, London.

Swedish Fellowships.—Mr. A. W. Bernton, Phil.Lic.; University of Oxford. Mr.

J. Lublin, Ph.D.; University of Cambridge.

Swiss Fellowship.—Temporarily vacant.

The total value of the annual amount of the Fellowships that is awarded is £5,007, of which £3,500 is provided by grants from Dominion and foreign sources.

GENERAL NOTES.

BRITISH CHEMICAL STANDARDS.

The organisers of the British Chemical Standard movement are pleased to announce the publication of the complete certificate of analyses of the following samples:—

	Carbon steel "C"	Carbon steel "P"
Carbon	*0.091%*	*0.207%*
Sulphur	—	0.073%
Phosphorus ...	—	0.105%
Manganese ...	0.50 % (approx.)	0.706%

	Cast Iron "D"
Phosphorus	1.19%

The samples were first issued about eight months ago, but it has not been possible to publish the full details of all the figures until now.

Each of the standard steels has been *tested by a selection of about a dozen prominent* chemists representing

Independent Analysts (Metallurgical).
U.S. Bureau of Standards,
English, French, Italian and U. States Iron and Steel Works Chemists (both makers and users).

A special feature of steel "P" certificate is that it contains full notes of the methods *actually used by the co-operating analysts.*

The standard samples may be obtained in 50, 100 and 500 gramme bottles, either direct from Organising Headquarters, 3, Wilson Street, Middlesbrough, or through any of the leading laboratory furnishers, at a price just sufficient to cover the cost. The usual certificate, giving the names of the analysts, the types of methods used, and a detailed list of the results, will be supplied with each bottle.

The full list of all the standards now available may be had on request.

THE IRON ORES OF BRITISH COLUMBIA.

The project of establishing on a large scale an iron-making industry in British *Columbia, using native ores and fuels,* has attracted more than local attention. Supporters of various proposals have contended that such a plant would not only have a monopoly of the market of western Canada, but also should be able to build up a large foreign market in countries bordering on the Pacific. It has been repeatedly as*serted that adequate supplies of iron ore,* fuel and fluxes are available at various places along the sea-coast of the province. The general subject being of very considerable national and provincial importance, the Geological Survey of Canada, in co-operation with the Department of Mines, British Columbia, has undertaken an inves*tigation of the iron ore resources of the pro*vince. It has long been known that many bodies of iron ore exist on or close to the mainland coast and the shores of Vancouver Island.

Except at a few localities where limonite or bog iron ore occurs, the deposits are all of magnetite, carrying no titanium and, so *far as known, having a very low phosphorus* content. Considerable progress has already been made in the examination of the known ore occurrences, and it is expected that by the end of the year 1924 sufficient information will have been collected as will definitely indicate whether or no there exists a reserve of iron ore sufficiently large to warrant the establishment of a blast furnace plant.

GERMAN SUGAR PRODUCTION.

The Commercial Secretary at Berlin has forwarded an extract from the *Frankfurter Zeitung,* which states that the production of sugar for consumption is estimated at 1,017,378 tons for 1923-24, as compared with 1,310,180 in the preceding year. The production of molasses in 1923-24 is estimated at 15,000 tons.

The sugar content of the beet, according to latest estimates, amounts to 15.31 per cent. on an average, as compared with 15.[illegible] per cent., the October estimate, and 15.[illegible] per cent., the actual average in the last crop year.—(*From the "Board of Trade Journal," January 31.*)

RICH MINERAL BELT.

Up to the end of 1923 the mines of Northern Ontario have produced over 600 million dollars in gold, silver, platinum, nickel and copper. More than 250 million tons of ore and rock has been taken from the nickel-copper mines of the Sudbury district, yielding approximately 255 million dollars, and placing in ascertained reserves at least another 100 million tons of ore, with an indicated gross value of two billion dollars.

The mines of the Cobalt, South Lorrain, and Gowganda district have produced over 340 million ounces of silver, valued at approximately 210 million dollars. Dividends from a great many of these silver mines have been exceedingly big—ranging from a few hundred per cent. to as high as twenty-five thousand per cent. on the capital invested. The silver bullion sent out from this few miles square of territory would make up approximately twenty trainloads of about twenty cars to each train.

PROCEEDINGS AND NOTICES OF SOCIETIES.

THE ROYAL SOCIETY.

THURSDAY, JANUARY 31.

Papers read:—

A. MALLOCK, F.R.S. *Summary of the Results obtained from Experiments made during the years 1918 to 1923 of the Effects of Temperature on the Properties of Metals.*

In this paper some results are given relating to the properties of iron and steel in the neighbourhood of the critical temperature.

It appears that the principal change which occurs at that temperature is an abrupt alteration in specific heat, which, as the metal passes to the high-temperature state, is reduced to about one-third of its previous value.

The coefficients of rigidity and thermal expansion undergo no discontinuous change.

The rigidity decreases slowly as the temperature rises to a low red heat, but at higher temperatures the change is rapid. At a bright red heat the metal still retains elastic properties, but with greatly increased viscosity, and thus oscillations which depend on rigidity are quickly

The presence of small quantities of Si, S, P, and Mn, in the samples used in the experiments, prevent any absolute conclusion being formed as to the effect produced by carbon alone, but it is clear that carbon lowers the critical temperature, and prolongs the time occupied in changing from the high to the low temperature state while the metal is cooling.

A. K. GOARD and E. K. RIDEAL. *Catalytic and Induced Reactions. Parts I. and II.* Communicated by Prof. T. M. Lowry, F.R.S.

Part I.

An electrode of special type has been devised whereby it is possible to effect the comparison of the potentials of certain substances which behave irreversibly towards the platinum electrode.

The action of cerous salts in effecting the induced oxidation of potassium arsenite, and the catalytic oxidation of five reducing sugars, have been investigated from the standpoint of oxidation potential. In the former case the potentials have been found to observe the order:—

Cerous salt (inductor)—arsenite (acceptor) — equilibrium mixture — perceric salt;

in the latter, the order:—

Reducing sugar — cerous salt — perceric salt.

as anticipated in the theoretical section of this paper.

Part II.

Schönbein's reaction (the separation of iodine from potassium iodide solution in the presence of hydrogen peroxide and ferrous salts) has been investigated from the standpoint of oxidation potential, and has been shown to conform to the schemes for coupled and catalytic reactions described in Part I. of this paper.

Direct evidence has for the first time been obtained of the formation of a peroxide of iron by the action of hydrogen peroxide upon ferrous sulphate in neutral solution, and its decomposition according to a monomolecular law has been followed by means of potential measurements.

This peroxide has been shown, by the method of electrometric titration under special conditions, to possess the essential

Papers read in title only:—

PROF. H. B. DIXON, F.R.S., and G. GREENWOOD. *On the Velocity of Sound in Gases and Vapours, and the Ratio of the Specific Heats.*

The authors have determined the velocity of sound in certain vapours and condensable gases by timing the passage of a sound-wave between the two ends of a coiled lead pipe filled with the vapour or gas between 20° C. and 100° C., and comparing the rates with the velocity of sound through air in the same pipe. From the velocities found in the pipe the velocities in the "free" gas are calculated, and from these results the specific heats of the gases and vapours are computed.

The authors have also recalculated the specific heats of the gases nitrogen, carbon dioxide, methane and ethane from the velocities of found in the "free" gases at high temperatures, published two years ago in the *Proc. Roy. Soc.*, A, Vol. C. (1921).

J. R. PARTINGTON, D.Sc., and A. B. HOWE. *The Ratio of the Specific Heats of Nitrogen and of Oxygen.* Communicated by Prof. H. B. Dixon, F.R.S.

The adiabatic expansion method of determining accurately the ratio of the specific heats of a gas, described in a previous communication, has been applied to nitrogen and oxygen. Gas at pressure p_1, slightly greater than atmospheric, is put into communication with free air, at pressure p_2, by suitable means, so that the equilisation of pressures occurs as nearly as possible adiabatically, and the fall in temperature is measured by means of a very fine platinum-wire bolometer. If T_1 and T_2 are absolute temperatures of gas before and after expansion, then, *for an ideal gas*,

$$\gamma = C_p/C_v = \frac{\log p_1 - \log p_2}{(\log p_1 - \log p_2) - (\log T_1 - T_2)}$$

The value so obtained was corrected by means of D. Berthelot's equation of state. A correction was also applied for the gain of heat by the bolometer wires by radiation. Specific heats at constant pressure and volume were also calculated by means of Berthelot's equation.

The gas was contained, at the pressure p_1, in a spherical copper globe of about 60 litres capacity, immersed in a water-bath maintained at constant temperature by means of an electrical thermostat. Pressure was measured on an oil manometer. The bolometer was used in conjunction with an Einthoven string galvanometer and a post-office box. The galvanometer was used as a null instrument, the lowest temperature, T_2, attained during expansion being reproduced by adding ice to the bath. The temperatures were determined by standardised mercury thermometer.

The following values were obtained for oxygen and nitrogen:—

	c_v.	c_p.	C_v.	C_p.	γ
Nitrogen at 20° C.	0.1759	0.2470	4.929	6.922	1.4045 + 0.0003
Oxygen at 20° C.	0.1581	0.2204	5.056	7.051	1.3946 + 0.0002

The value of c_v for air calculated from values for oxygen, nitrogen and inert gases, agreed with that previously found experimentally.

S. BARRATT. *The Absorption Spectra of Mixed Metallic Vapours.* Communicated by Prof. T. R. Merton, F.R.S.

An absorption band spectrum was described, which is developed only in mixtures of the vapours of sodium and potassium.

Contrary to previous statements, the line $1S - 2p_2$ of magnesium has been observed in absorption.

E. P. METCALFE and B. VENKATESACHAR. *On Selective Absorption by Luminous Mercury Vapour.* Communicated by Prof. A. W. Porter, F.R.S.

The absorption of the components of the 5461 A group ($1p_1 - 1s$) by luminous mercury vapour has been examined, with the aid of a Lummer-Gehrcke plate and an absorbing column 100 cm. long. All the satellites were found to be strongly absorbed, under suitable conditions, with the exception of − 0.237 A, which was also absorbed, but to a much less degree. The ratio of emission to absorption is found to be fairly constant for all the lines, except − 0.237 A. All the resolved satellites, except − 0.237 A, have been reversed on a continuous bright background. The conditions for reversal are discussed. The bearing of these results on the possible isotopic origin of some of the satellites is considered.

The absorption and reversal of the lines

5769 A (1P - 2d') and 5791 A (1P - 2D), for which the absorption centres are the same, nad in the state 1P, have been observed. Two satellites of 5769 A (0.044 A and - 0.050 A) have been reversed.

The effectiveness of long columns as radiators of weak lines is brought out by the observation of the feeble satellite - 0.112 A of 5679 A in the light radiated from the end of a 100-cm. column carrying a current of 0.06 amperes per sq. cm.

THE ROYAL SOCIETY OF ARTS.

On Monday, Feb. 4, the third Cantor lecture, entitled *Colloid Chemistry,* was given by ERIC KEIGHTLEY RIDEAL, M.A., PH.D., D.Sc., F.I.C.

On Tuesday, Feb. 5, at a meeting of the Dominions and Colonies Section, a paper entitled *The Commercial Future of the Backward Races, with Special Reference to Papua,* was read by F. W. WALKER, Managing Director, Papuan Industries. Sir George R. Le Hunte, G.C.M.G., presided.

On Wednesday, Feb. 6, at the Ordinary Meeting, a paper entitled *The Earthquake and the Work of Reconstruction in Japan,* was delivered by IYEMASA TOKUGAWA, O.B.E., First Secretary to the Japanese Embassy. The paper was illustrated with cinematograph views. Lord Askwith, K.C.B., K.C., D.C.L., Chairman of the Council, presided.

THE ROYAL INSTITUTION OF GREAT BRITAIN.

The Friday evening discourse on Feb. 8 was delivered by SIR ARTHUR EVANS, D.LITT., LL.D., F.R.S., on *Recent Lights on the Minoan Art of Crete.*

On Tuesday, Feb. 5, PROF. ARTHUR DENDY, D.Sc., F.R.S., gave his second lecture on *What is Heredity?*

On Thursday, Feb. 7, SIR WILLIAM BRAGG, D.Sc., F.R.S., gave his first lecture on *Crystalline Structure of Organic Substances.*

THE SOCIETY OF CHEMICAL INDUSTRY.

MANCHESTER SECTION.

A meeting of the Section was held at the Textile Institute, Manchester, on January 11, Dr. E. Ardern presiding, in the absence of Dr. Levinstein, who was attending a meeting of the Council in London.

A paper, entitled *Fractional Distillation,* by MESSRS. C. ELLIOTT, B.Sc., A.M.I.C.E., and A. BRITTAIN, M.Sc., A.I.C., was read by the first-named author.

Mr. Elliott said that the subject of Fractional Distillation covers a very wide field, but it is rather surprising that more is not written on the subject when one considers its many applications in industry. On the technical scale, the design of distillation plant has been, and still is, based almost entirely on practical experience and by the use of empirical rules. The scientific study of the subject is still in its infancy as far as its co-ordination with the practical side is concerned, and there is no doubt that much would be gained if theory could supply more useful data.

The effect of altering the pressure under which a distillation is carried out on the composition of the distillate from miscible liquids which do not form constant boiling point mixtures has received but little attention. Usually, in practice, the external pressure is reduced in order to lower the boiling temperature of the liquids being distilled, and consequently to minimise the tendency to decompose or polymerise in the case of many liquids. The more difficult aspect whether the liquids can be separated by fractional distillation more easily at pressures greater than atmospheric, at atmospheric pressure, or under reduced pressure, is never or rarely taken into account. The reason for this lack of consideration is very obvious, for practically no scientific information is at the disposal of the refiner, although vacuum distillation is very widely employed in industry.

Using the excellent laboratory apparatus described by M. A. Rosanoff (*Trans. Amer. Chem. Soc.*, 1914), a series of distillations was carried out under atmospheric and reduced pressures, and the respective curves drawn establishing the relationship between the composition of the liquids and of the vapours in equilibrium with them. Thus, in the case of pyridine and the cre-

sols, the effect of reducing the pressure from 750 mm. to 45 mm. shows very striking differences in the composition of the distillate, and points to a tendency, at least, towards the formation of constant boiling-point mixtures or actual combinations.

The change in the composition of the distillate from binary mixtures, due to change in pressure, depends on the variation of the ratio of the vapour pressures of the substances in the free state and on the heat of dilution developed when they are mixed together. This change can be calculated accurately for certain ranges of temperature.

Viewed from the aspect of ease of separation by fractional distillation, and irrespective of the avoidance of decomposition, it is apparent that, in certain classes of liquids, it would be advantageous to work not at the lowest possible pressure, but at one particular pressure, or even by varying the pressure continuously throughout the distillation. In distilling *in vacuo*, as compared to working at atmospheric pressure, one should remember that the latent heat of the substances, and therefore the steam required, is increased, the volume of the vapours is greater, and the water required in the dephlegmating and final condensers is increased because the temperature difference between it and the vapours is lower and the latent heat higher. The size of the bubbles on the trays would also be larger than under atmospheric pressure. Equilibrium between the bubbles and the liquor on the trays is never attained, except perhaps on the outside surfaces of the bubbles, unless severe distortion and breaking up of the bubbles occurs. One would expect, therefore, that the efficiency of separation obtained with a given column would be lower when working under reduced pressure than under atmospheric pressure if the same liquids are distilled.

A second paper, entitled *The Use of the Lead Cathode in the Electrolytic Method for the Estimation of Minute Amounts of Arsenic*, by T. CALLAN, M.Sc., PH.D., was also read.

Dr. Callan stated that lead cathodes used in the electrolytic method for the detection of minute amounts of arsenic show certain irregularities after being in use for some time, and these irregularities and their cause and elimination were dealt with in the paper.

One of the chief causes of insensitivity of lead cathodes, that is, failure to give off the full amount of arsenic added to the electrolytic cell, in the form of arseniuretted hydrogen, is due to overworking the cathodes, when they apparently become coated with a layer of sulphate or oxysulphate of lead. Such inactive cathodes can be restored to their normal sensitivity by treatment for a few minutes with warm dilute nitric acid. If, however, lead cathodes are treated repeatedly with hot dilute nitric acid, they become quite insensitive, although possessing a bright metallic surface.

Lead cathodes thus rendered insensitive can be reactivated by the addition of a minute amount of cadmium sulphate to the electrolytic cell.

THE INSTITUTE OF CHEMISTRY OF GREAT BRITAIN AND IRELAND.

JANUARY EXAMINATIONS, 1924.

Pass List.

The following candidates have passed the examination for the Associateship:—

In General Chemistry:

Cohen, David Solomon, East London College; Doyle, Robert Cecil, Chelsea Polytechnic; Exell, Harold Cyril, King's College, London; Goldthorpe, Harold Hopwood, B.Sc. (Lond.), Huddersfield Technical College; Hare, Andrew Thomas Stewart, Heriot-Watt College, Edinburgh; Hornby, Frederick Percival, University College, Southampton, and Northern Polytechnic Institute; Johnston, James, B.Sc. (Lond.), Heriot-Watt College, and The University, Edinburgh; Pullen, Alfred Norman Douglas, University College, Reading; Radford, William Howard, University College, Nottingham; Watridge, Roy Warren, B.Sc. (Lond.), University College, Southampton; Wood, Ralph John, East London College.

Nineteen candidates failed to satisfy the examiners.

By order of the Council,

RICHARD B. PILCHER,

Registrar and Secretary.

30, Russell Square, London, W.C.1.
January 25, 1924.

JUNIOR INSTITUTION OF ENGINEERS.

At a special meeting of the Junior Institution of Engineers, on January 25, PROF. EDWIN EDSER delivered a lecture on *Molecular Attraction and its Relation to Engineering.* The lecture was illustrated throughout by a number of interesting experiments, slides and sketches, and dealt in a practical manner with engineering methods and problems which are based on principles of molecular attraction.

Prof. Edser explained how liquids have tensile strength just as much as solids, and demonstrated by sketches the nature of surface tension and capillary attraction. Capillary attraction is the cause of water permeating brick walls, although this can be avoided by a coating of some waxy substance, and in order to render road surfaces waterproof they are in many cases treated with emulsified tar.

The amount of energy which is brought into play by molecular attraction is not always realised, but two experiments showed that the rate at which a minute film of oil will spread over water, and even along the interface of two different liquids, such as water and paraffin, is conclusive that excessively high pressures must be present. The oil used in the experiments was oleic acid, which is of a viscous nature, and could not go at such a speed through so small a space unless it were under very high pressure.

The lecturer referred to the discovery during the building of the Nile dam of a monolith similar to Cleopatra's Needle. This monolith was found only partially cut from the rock and apparently it was being severed by making a line of holes and plugging them with wood. By wetting the wood great pressures were produced, which eventually made a crack in the required place.

The rubbing of particular surfaces together may cause unlooked for results, but every negineer now knows that a brass shaft will not work in a brass bearing unless it is given particular attention in the way of lubrication. On the other hand, metal surface plates can be made by burnishing with a suitable material, and a razor blade can be sharpened by passing it between two steel balls and applying the right amount of pressure.

In answer to questions raised during the discussion, Prof. Edser explained why oil could calm the waves, how paraffin removes rust, and the part that a flux takes in soldering operations.

THE PHYSICAL SOCIETY OF LONDON.

The Annual General Meeting will be held at 5 p.m. on Friday, February 8, 1924, at the Imperial College of Science, South Kensington, S.W.

AGENDA.

1.—Secretary's Report.
2.—Treasurer's Report.
3.—Election of Officers and Council.
4.—Presentation of the Duddell Memorial Medal to Prof. H. L. Callendar, LL.D., D.Sc., F.R.S.

The Annual General Meeting will be followed by an Ordinary Meeting, at which the following papers will be read:—

1.—*Æolian Tones*, by E. G. RICHARDSON, M.Sc., East London College.
2.—*Effect of Torsion on the Thermal and Electrical Conductivities of Metals*, by J. E. CALTHROP, B.A., B.Sc., East London College.

A Demonstration of a "Microscope for Observation of Interference Fringes" will be given by C. W. Hawksley.

DISCUSSION ON LOUD SPEAKERS.

The Joint Discussion on "Loud Speakers for Wireless and other Purposes," arranged by the Physical Society and the Institution of Electrical Engineers, will be continued at a meeting on Thursday, February 14, from 6 to 7.30 p.m., to be held at the Institution of Electrical Engineers.

Proceedings of the meeting on January 25, Alexander Russell, M.A., D.Sc., in the chair:—

A lecture, entitled *Recent Work in Stellar Physics*, was delivered by E. A. MILNE, M.A., Fellow of Trinity College, Cambridge, and Assistant Director of the Solar Physics Observatory, Cambridge.

The lecture included a review of the relation of stellar spectra to modern spectral theory, with reference to giant and dwarf stars and to recent additions to our knowledge of stellar temperatures. Methods of deducing certain atomic quantities from astrophysical evidence were proposed.

Sir Richard Glazebrook, K.C.B., F.R.S., in proposing a vote of thanks to the lecturer, commented on his learned and lucid exposition of many difficult points. The ground covered indicated that astrophysics was beginning to repay the debt which it owed to physics.

Dr. C. Chree, F.R.S., seconding the vote of thanks, remarked that those who had listened to the lecture must feel rather highly ionised and wishing their coefficients

of absorption had been somewhat higher. It was clear that recent experimental advances in our laboratories had permitted of fertile and highly diverting speculations in regard to the order of events in the life-history of the stars.

THE INSTITUTION OF ELECTRICAL ENGINEERS.

The Faraday Medal.

The Council of the Institution of Electrical Engineers have made the third award of the Faraday Medal to Dr. S. Z. de Ferranti, a past President of the Institution.

The Faraday Medal is awarded by the Council of the Institution not more frequently than once a year, either for notable scientific or industrial achievement in electrical engineering, or for conspicuous service rendered to the advancement of electrical science, without restriction as regards nationality, country of residence, or membership of the Institution.

Dr. Ferranti was a pioneer in the supply of electricity, and his early grasp of the fundamental principles of electric power supply have had a profound influence, not only in this country, but all over the world.

THE INSTITUTE OF PHYSICS.

The sixth of the series of lectures on *Physics in Industry*, was delivered on Wewnesday, February 6, in the rooms of the Chemical Society, Burlington House, W. The lecturer was Prof. C. H. Desch, F.R.S., and his subject *The Physicist in Metallurgy*.

THE CHEMICAL SOCIETY.

Ordinary Scientific Meeting, Thursday, February 7.

The following papers were read:—

The Solubility of the Aminophenols, by N. V. Sidgwick and R. K. Callow.

Abnormal Benzene Derivatives, by N. V. Sidgwick and R. K. Callow.

New Patents.

This list is specially compiled for *The Chemical News* by Messrs. Rayner & Co., Registered Patent Agents, of 5, Chancery Lane, London, from whom all information relating to Patents, Trade Marks, and Designs can be obtained gratuitously.

Latest Patent Applications.

1305—Farbenfabriken vorm. F. Bayer & Co.—Manufacture of nitric acid. Jan. 16.

1314—Farbwerke vorm. Meister, Lucius & Bruning.—Manufacture of arsenic and antimony

1039, 1043—Albert, A.—Process for producing organic compounds of mercury. Jan. 14.

Specifications Published this Week.

209124—Davies, H., and Adam, M. A.—Detinning of tinned iron scrap.

192003—*Texas Gulf Sulphur Co., Inc.*—*Method* of and apparatus for burning sulphur.

209171—Koppers Co.—Manufacture of hydrogen sulphide.

208832—Koppers Co.—Manufacture of alkali sulphides from thiosulphates.

Abstract Published this Week.

206734—Nitroso compounds.—British Dyestuffs Corporation, Ltd., of 70, Spring Gardens, Manchester, and Hodgson, H. H., of 136, Paley Road, Bradford.

p-Nitroso-m-halogen-phenols are prepared by treating *m*-chlor, *m*-brom-, or *m*-iodo-phenol with nitrous acid. In an example a solution of *m*-chlorphenol in caustic soda and sodium nitrite in water is slowly acidified with sulphuric acid; hot acids convert the yellow product into a reddish body, possibly the quinone oxime form, which, by treatment with alkali yields a pale yellow body which can be precipitated by acids.

Messrs. Rayner & Co. will obtain printed copies of the published specifications and abstract only, and forward on post free for the price of 1s. 6d. each.

THE RECUEIL DES TRAVAUX CHIMIQUES DES PAYS-BAS contains original scientific papers in one of the three languages, namely, English, French, or German, according to the wish of the writers. It comprises about 800 pages per annum (1,100 pages in 1923). The subscription price is 16.50 florins (including postage).

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THE CHEMICAL NEWS,

VOL. CXXVIII. No. 3331.

THE PLENTIFUL HARVEST OF WHEAT IN 1923.

The plentiful yield of the wheat harvests during the past season has been responsible for a general idea that the area under cultivation for this cereal was an excessive one. The International Institute of Agriculture states, in its Crop Report for January, 1924, that it is a matter of interest to examine, in regard to the large out-turn of 1923 (and of 1923-24 in the southern hemisphere), how far the result was due to an extension of cultivated area, and how far it was a consequence of an exceptionally favourable season, conducive to yields much beyond those customary.

The areas under wheat, averaged for the five pre-war years, and as in each of the years from 1919 to 1923, are indicated below. The European figures are exclusive of present-day Russia.

Years.	Thousand acres.
1909 to 1913 average ...	190,118
1919	206,868
1920	201,308
1921	208,606
1922	210,379
1923	212,942

As compared with the pre-war data, the areas under wheat thus show a decided increase in the aggregate for those great producing countries which are included. But the following points should be noted:

(1) Russia has *no place* in our totals. In pre-war years this country exported large quantities of wheat and flour, attaining an average for the five years 1909 to 1913 of about 95 million centals. It is only during the last few months that any renewal of exports has taken place, but on a relatively small scale. A portion of the increased area in other countries goes to compensate the great falling-off in Russian contribution towards world supply.

(2) The new areas devoted to wheat growing are less fertile than those previously included; thus the additional yields are not proportionate to the extension of cultivation.

(3) During the last decade the world's population has increased, and the consumption of wheat has also become more widely spread in countries outside Europe. These facts have largely counterbalanced the restricted consumption in some European countries, consequent on their disorganised financial and economic condition.

The aggregated force of these reasons may be held to prove that the increase in wheat areas for the four-year period 1919-1922 in comparison with the five pre-war years, was a response to the actual consumption requirements of the world at large. It follows that the 1919 to 1922 crops were in no way burdensome.

In 1923 the cultivated area registered a new increase, reaching 212.9 million acres, as compared with an average of 206.8 million during the previous four years. We have therefore an addition of merely 3 per cent., while the production was 18 per cent. larger.

This comparison at once demonstrates the fact that the exceptionally plentiful yield in 1923 was, *on its main lines*, due to climatic conditions particularly favourable to the wheat plant. In fact it is only necessary to note the figures of yields per acre, to see that not one of the great producing countries had an output below the average for the previous five years, and, further, that all of them, with the sole exception of the United States, had exceeded this average.

Yield per acre in Centals.

Countries.	Average 1919 to 1923.	1923.
Europe (1) ...	10.4	11.7
North Africa	6.5	7.7
Canada	9.1	12.4
United States ...	8.0	8.1
India	7.1	7.2
Argentina	7.5	9.0
Australia	7.1	7.2
All countries ...	8.6	9.5

(1) Exclusive of Russia.

The fact of simultaneous good yields in all producing countries is a very unusual one. Ordinarily, if there are large crops in some countries, the results in other lands are poor. On examination of the excess or deficiency in the yield per acre obtained in each separate harvest during the three quinquennial periods, in relation to the average for the corresponding quinquennium, it may be observed that only on one

other occasion in all the fifteen years (in 1915) were there universal yields above average.

The rare coincidence of simultaneous favourable conditions for the wheat crop in all the principal producing countries, renders it improbable that the very satisfactory results of 1923 will be often repeated.

Seeing that the recent plentiful wheat crop is only in part attributbale to an increased acreage, and mainly to an exceptionally propitious season, it is desirable to bear in mind that the present campaign is unlikely to meet with sucb favourable circumstances, also that the decrease in area sown with winter wheat for the 1924 crop in the United States is about 6 million acres, thus practically cancelling the entire extension of wheat cultivation registered in 1923 in comparison with the period 1919-1922.

LITERARY INTELLIGENCE.

The Cambridge University Press will shortly publish for the Cambridge Philosophical Society a translation, in two parts, of Dr. Niels Bohr's papers "On the Application of the Quantum Theory to Atomic Structure." Part I., which will appear immediately, is entitled "The Fundamental Postulates of the Quantum Theory," and will be closely followed by Part II., "The Theory of Series Spectra." Dr. Niels Bohr's new work is closely allied to his previous book, "The Theory of Spectra and Atomic Constitution," also published by the Cambridge University Press, the first impression of which is now almost exhausted.

CRITICAL STUDIES ON METHODS OF ANALYSIS.

IV.—Aluminium.

By Leon A. Congdon and John A. Carter.

(Contribution from the Department of Chemistry, Syracuse University.)

Introduction.

After a considerable study of the literature some sixty-six references were collected relative to the estimation of aluminium or its separation from other interfering elements, so that the element could be determined. There was found about twenty-seven gravimetric procedures or modifications. Twenty-eight studies referred to the separation of some element or elements that interfere with the regular gravimetric procedures. Eight methods or modifications referred to the use of volumetric analysis for aluminium salts. One colorimetric method was encountered for small amounts of aluminium. Two indirect gasometric methods were recorded.

For this study, seven methods or modifications seemed worthy of critical examination, five gravimetric and two volumetric. The gravimetric processes studied were W. Blum's (1) method as the precipitated hydroxide; L. Belasio's (2) method as the precipitated hydroxide in the presence of tartaric acid; W. H. Krug's (3) method in the presence of phosphates by use of ammonium molybdate; I. Ivanov's (4) process by *sodium thiosulphate, KI and KIO_3*; and E. Schum's (5) procedure by ammonium nitrite solution. The volumetric methods studied were R. Gatenby's (6) method of determination of aluminium with N/2 NaOH; and T. J. I. Craig's (7) volumetric procedure by use of potassium fluoride.

Principle of the Methods.

1st.—W. Blum's metbod determines aluminium as the weighed oxide by precipitating first as the hydroxide with NH_4OH after NH_4Cl has been added to precipitate Mg, if present, with particular attention paid to the hydrogen-ion concentration.

2nd.—L. Belasio's process estimates aluminium as the weighed oxide by precipitating first as the hydroxide after crystalline

(1) Blum, W., *Jour. Amer. Chem. Soc.*, 1916, XXXVIII., 1282-1297.

(2) Belasio, L., *Ann. Chem. applicata*, 1914, I., 101-110.

(3) Krug, W. H., *Chem. News.*, 1892, LXV., 68, 78, 89, 98.

(4) Ivanov, I., *Jour. Russ. Phys. Chem. Soc.*, 1914, XLVI., 419-427.; *Chem. Abst.*, 1914, VIII., 3765.

(5) Schum, E., *Chem. Zeit*, 1909, XXXIII., 877.

(6) Gatenby, R., *Chem. News*, 1887, LV., 289.

(7) Craig, T. J. I., *Jour. Soc. Chem. Ind.*, 1911, XXX., 185.

tartaric acid has been added to prevent other substances than aluminium from being precipitated. Two precipitations of the aluminium are made, the first precipitate being dissolved in HCl.

3rd.—W. H. Krug's method determines aluminium as the weighed oxide by first adding ammonium molybdate, HNO_3, and ammonium nitrate, in order that phosphates, which if present would interfere, may be precipitated. The filtrate used for analysis is treated with NH_4OH until slightly alkaline, and the precipitate washed with ammonium nitrate solution. The precipitate is then dissolved with a mixture of HNO_3 and ammonium nitrate, and reprecipitated with ammonia in the regular way.

4th.—I. Ivanov's procedure weighs the aluminium as the oxide, but does not call for a reprecipitation of the hydroxide. He first neutralises the solution to be precipitated with sodium thiosulphate, then dilutes to 100 cc., and adds KI until the action ceases. For precipitating he adds 3 per cent. solution of KIO_3 and a 10 per cent. solution of KI until precipitation is complete. The solution is then boiled about five minutes to expel excess iodine. The precipitate is then washed with a neutral solution of ammonium nitrate.

5th.—E. Schum's method also weighs the aluminium as the oxide, but neutralises the solution of the sample with NH_4OH, just avoiding a precipitate. The sample is diluted to about 250 cc., and precipitation is brought about by 20 cc. of a·6 per cent. ammonium nitrite solution. Solution is then boiled to expel oxides of nitrogen. After precipitate settles by placing on a water bath for about 20 minutes, it is washed by decantation with a neutral solution of ammonium nitrite.

6th.—R. Gatenby's volumetric method by N/2 NaOH is based on the fact that the acid combined with the aluminium behaves towards indicators as though it were in the free state. Phenolphthalein is used as an indicator, and the red colour showing the presence of base does not appear until the aluminium has been precipitated completely. The chloride of aluminium is best used for this determination as the sulphate very often contains free acid, which must necessarily be accounted for if present.

7th.—T. J. I. Craig's volumetric process by use of potassium fluoride is based on the fact that an excess of potassium fluoride decomposes aluminium salts, forming two compounds which read neutral to phenolphthalein, while the free acid remains unaltered. The calculation is simple, the per cent. of aluminum oxide being given by the volume of standard NaOH added, minus the corrected volume of the standard acid added. The number is then divided by 4. From this the per cent. of aluminum may be determined.

EXPERIMENTAL.

The sample used in all methods studied was a pure salt of aluminum chloride, $Al_2Cl_6.12H_2O$, containing only 0.024 per cent. of iron, and having no H_2S metals or sulphates present. The sample for analysis was prepared by dissolving 10.8 grams of this salt made up to a litre with water. Aliquots were taken for the various determinations made.

Some of the difficulties noted in the seven methods studied are as follows:—W. Blum Method: The precipitate is soluble in both acid and basic solutions. The washing solution of ammonium nitrate must be absolutely neutral or some of the aluminum hydroxide will dissolve, and weight will be low. The precipitate is also soluble in water.

L. Belasio's Method: The tartaric acid is sometimes difficult to dissolve, and the washing solution for the precipitate of aluminum hydroxide must be neutral.

W. H. Krug's Method: Care must be taken not to get the solution too alkaline, as some of the precipitate is dissolved by the excess ammonia. The precipitate dissolves mor eslowly with the nitric acid and ammonium nitrate than the hydrochloric acid.

I. Ivanov Method: No particular difficulties, and the precipitation is prompt and complete. The results, however, are a little low, probably due to the complete absence of any iron which may have been precipitated in some of the other determinations.

E. Schum Method: Care must be taken not to have excess ammonia, which will dissolve the precipitate.

R. Gatenby Volumetric Method: No particular difficulties when the sample analysed is some salt of aluminum.

T. J. I. Craig Volumetric Method: The water used in this determination must be free from carbon dioxide, as it reacts with the indicator phenolphthalein. To remove this difficulty, the distilled water used must be boiled. If the sample is not clear when dissolved, digest on water bath with about 10 cc. of acid. If the solution darkens when titrated, it shows that there is

not enough KF in the solution, and a new determination must be made with addition of more KF. If ammonia salts are present in the sample, they must be removed by boiling with standard KOH solution:

The following table gives the results of this comparative study of the seven methods:—

Wt. sample grams.	Process.	P.c. Al in sample.	P.c. Al obtained.	Avge. p.c. Al obtained.	Diff. p.c.
0.2160	W. Blum's Gravimetric	11.25	11.88 12.02	11.95	+0.70
0.2160	L. Belasio's Gravimetric	11.25	11.36 11.46	11.41	+0.16
0.4320	W. H. Krug's Gravimetric	11.25	11.42 11.45	11.45	+0.20
0.2160	I. Ivanov's Gravimetric	11.25	10.95 10.94	10.95	-0.30
0.2160	E. Schum's Gravimetric	11.25	11.30 11.27	11.28	+0.03
6.307	R. Gatenby's Volumetric	11.25	11.3 11.3	11.30	+0.05
6.307	T. J. I. Craig's Volumetric	11.25	11.27 11.27	11.27	+0.02

From the table of results obtained by seven methods of analysis, the accuracy of the methods can be classed as follows:—1st, T. J. I. Craig's volumetric; 2nd, E. Schum's gravimetric; 3rd, R. Gatenby's volumetric; 4th, L. Belasio's gravimetric; 5th, W. H. Krug's gravimetric; 6th, I. Ivanov's gravimetric; and 7th, W. Blum's gravimetric.

All methods came within the experimental errors with the exception of two methods, namely, W. Blum's gravimetric method, with a difference in per cent. of aluminum of +0.70, and I. Ivanov's gravimetric method, with a difference in per cent. of aluminum of -0.30 from the theoretical amount of aluminium in the sample examined.

Summary and Conclusions.

1.—Seven methods of analysis were examined for the per cent. of aluminum in a sample of aluminum salt, $Al_2Cl_6 \cdot 12H_2O$. Five of the methods were gravimetric ones and two were volumetric.

2.—The methods of analysis studied may be classed as follows, in order of their accuracy, the most accurate being placed first:—Craig's volumetric, Schum's gravimetric, Gatenby's volumetric, Belasio's gravimetric, Krug's gravimetric, Ivanov's gravimetric, and Blum's gravimetric.

3.—The most rapid and accurate gravimetric process is that of E. Schum, where the dissolved sample is neutralised with diluted to 250 cc. with water and precipitation brought about with a solution of 6 per cent. ammonium nitrite and boiled to expel oxides of nitrogen. The precipitate is washed once or twice by decantation with a neutral solution of ammonium nitrite, filtered on filter paper, washed, ignited, and weighed as the oxide.

4.—The most rapid and accurate volumetric process is that of T. J. I. Craig, based on the fact that an excess of potassium fluoride decomposes aluminum salts, forming two compounds, which read neutral to phenolphthalein, while the free acid remains unaltered.

THE STRUCTURE OF VANADIUM.

By Hawksworth Collins.

All the following facts and experimental results demonstrate that an atom of vanadium has been formed by the union of an atom of magnesium with one of aluminium.

(1) The atomic weights of V, Mg and Al are 51, 24 and 27 respectively, and 51 = 24 + 27.

(2) The valency of V is 5, that of Mg 2, and of Al 3; and 5 = 3 + 2.

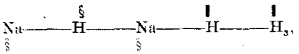
(3) 51 can be split up in the uniform manner demonstrated in the last paper (*The Chemical News*, 1924, CXXVIII., 3330, p. 81-82).

$$54 = 23 + 1 + 23 + (1 + 3)$$
and
$$51 = 39 + 1 + 7 + (1 + 3)$$

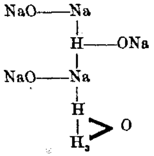
No other number between 48 and 54 inclusive can be split up in this particular manner into 5 parts, *i.e.*, into as many parts as the number of the column in which it occurs in the Periodic Table; or, in other words, into as many parts as the number representing the valency of the element.

(4) The presence of the Helium portion (1 + 3) shows that it is a non-metallic element, one electro-positive force emanating from each of the parts 1 and 3, and electro-negative forces from each of the parts 23, 1, 23.

The atom of vanadium is therefore:



where the thick lines represent electro-positive valences, the curly lines electro-negative valences, and the thin lines denote the forces which are not chemically evident, and which have to be overcome before the atom can be split up experimentally into parts. A molecule (*e.g.*, Na_3VO_4), in which the full number of valences of V are active would therefore be:



where the two electro-positive valences of the helium portion combine with the two electro-negative valances of an atom of oxygen, and the three electro-negative forces each combine with a basic (electro-positive), ONa.

Whatever may happen in the future towards the direct experimental verification of parts of the above theory, the following independent demonstration is inc... direct experimental verification, discoveries, which are revealed th... only be made in the manner in w... have been made, i.e., by correct upon experimental data.

(5) The first discovery in this connection is that of the exact relative volume of each atom in a molecule. That the reasoning part of the process has been carried on in the right manner is proved by the resulting discovery of a new law, which is here published for the first time:—

The relative volume of an atom is the sum of the relative volumes of its parts, any of which, but not all, may be zero.

This law will be demonstrated in this and succeeding papers, each of which will deal with one element.

The latter part of the law means that one portion of an atom may be drawn completely inside the remaining portion, so that the whole atom takes the form of the latter portion.

There are two other laws which have lately been published in *The Chemical News*, and which are dependent upon relative volume, viz., the Law of Heat of Formation (*The Chemical News*, August 18 & 25, 1922), and the Law of Magnetic Rotation (*The Chemical News*, Mar. 29, 1923); so that, when it is asserted that the exact relative volume of an atom has been discovered, the reason for this certainty is that, as long as the required experimental data are attainable, the relative volume has to satisfy three laws.

TABLE I.

The Relative Volumes of Vanadium.

	V	=	Mg	+	Al
Pentadic	17.76	=	8.71	+	9.05
Triadic	9.05	=	0	+	9.05
Dyadic	8.71	=	8.71	+	0
Dyadic	7.51	=	7.51	+	0

Also, since by the Inter-relationship of the Elements (*The Chemical News*, Apr. 9, 1920), V may appear to have been formed by the union of Na and Si:—

	V =	Na	+	Si
	51 =	23	+	1-23-1-3
	5 valences =	1 valence	+	4 valences
Tetradic	13.02 =	0	+	13.02

These five relative volumes of vanadium will now be demonstrated (Table II.), by dividing the molecular weight of a substance by ... theoretical specific gravity, ...up the relative volume thus ...parts. All theoretical and ex...ults given in this and following ... agree within one per cent. ...ered so that reference may ...m in later papers.

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TABLE II.

			Theor. S.G. at 15° C.	Obs. S.G. & Observer.
(1)	V_2O_5	2(17.76) + 7.53 + 4(2.51)	3.43	3.357 18°/4 V.N. 3.47 20° Schafarik
(2)	$BiVO_4$	21.29 + 17.76 + 7.53+3(2.51)	5.99	5.91 Frenzel 6.249 (name lost)
(3)	BiI_3	21.29 + 3(27.75)	5.644	5.64-5.65 20° Gott
(4)	$VOCl_3$	17.76 + 7.53 + 3(23.01)	1.84	1.836 17°.5 Roscoe 1.854 18° L'Hôte
(5)	$POCl_3$	14.56 + 7.53 + 3(23.01)	1.685	1.686 15° Buff
(6)	$PbCu(OH)VO_4$	17.42 + 9.54 + (2.51 + 5.76) + 17.76 + 7.53 + 3(2.51)	5.893	5.894 Roscoe
(7)	PbO	17.42 + 7.53	8.90	8.74 - 9.09 Geuther
(8)	CuS	9.54 + 15.53	3.790	3.8 Van Nostrand
(9)	$Ag_{12}V_8O_{26}$	12(10.25) + 8(17.76 + 7.53) + 18(2.51)	5.689	5.67 18° Carnelley ∴ 5.68 15°
(10)	AgI	10.25 + 32.77	5.44	5.47 0° Deville 5.35 Schiff
(11)	V_2S_5	2(17.76) + 5(10.51)	2.975	3.0 Kay
(12)	V_2S_3	2(9.05) + 3(10.51)	3.99	3.7 - 4.0 Kay
(13)	V_2O_3	2(9.05) + 7.53 + 2(2.51)	4.89	4.87 18°/4 V.N.
(14)	V_2S_2	2(8.71) + 2(10.51)	4.318	4.2 - 4.4 Kay
(15)	V	9.05	5.635	5.5 15° Roscoe 5.866 Setterberg
(16)	VCl_2	7.51 + 2(15.085)	3.238	3.23 18° Roscoe ∴ 3.238 15°
(17)	VCl_4	13.02 + 4(23.01)	1.837	1.836 8° Roscoe 1.8653 0°/4 V.N.
(18)	$VOCl_2$	13.02 + 4.45 + 2(15.085)	2.897	2.88 13° (solid) Roscoe
(19)	$MgO.MgCO_3 + 3H_2O$	8.71 + 2.51 + 8.71 + 20.55 + 3(14.03)	2.156	2.152 International
(20)	MgO	8.71 + 2.51	3.565	3.5699 0° Ditte
(21)	MgO	7.51 + 4.45	3.345	3.200 Karsten 3.42 Brugelmann
(22)	$MgCO_3$	7.51 + 20.55	3.0	3.007 Jenzsch
(23)	Al_2O_3	2(9.05) + 3(2.51)	3.98	3.98 14° Grandeau
(24)	$Al(OH)_3$	9.05 + 3(2.51 + 5.76)	2.30	2.3 Chemiker Kalender
(25)	$CaSi_2$	12.24 + 2(13.02)	2.508	2.5 Van Nostrand

The above results are confirmed by those given in *The Chemical News,* Aug. 18, 1922, and Mar. 29, 1923, and will be supported by many others later.

Heat of Formation of V_2O_5 2(-53305) + 32341 + 4(96155) = 310351.

By direct experiment, 310500. No name given (American publication).

$$-53305 = 120 \times (-8.71) \times 51$$

So by the law (*The Chemical News,* Aug. 18 & 25, 1922) the volume of V increases by 8.71.

$$9.05 + 8.71 = 17.76.$$

This is therefore another exact confirmation of the law.

It seems that the scientist who found this experimental value for V_2O_5 attempted, as Thomson did in other cases, to calculate the H.F. of other compounds of V from this result. That this is impossible is evident from the varying volumes of the elements concerned.

The above heat of formation of the oxygen atoms is explained in *The Chemical News,* August 25, 1922.

STUDIES IN THE REACTIONS OF THE AMINO GROUP IN 4' AMINO 1 PHENYL 5 METHYLBENZOTHIAZOLE.

PART IV.—THE ARSENICAL FUSION OF DEHYDROTHIOPARATOLUIDINE.

By R. F. HUNTER, F.C.S.

(*Continued from Page 88.*)

Dehydrothioparatoluidine (1), being a primary amine, should form an arsenate with arsenic acid in the usual way, in the same way as aniline forms an arsenate. When aniline arsenate is heated, however, the arsenical group migrates to the free para position to form 4 aminophenyl 1 arsinic acid (2), the sodium salt of which is atoxyl, the one-time cure for sleeping sickness.

$$CH_3C_6H_3 <^{S}_{N}> C\ C_6H_4NH_2$$

(1)

$$(OH)_2\ O\ As\ C_6H_4NH_2$$

(2)

Now the para position to the amino group in dehydrothiotoluidine is already substituted with the methyl benzothiazole ring. Nevertheless, we should expect migration to take place to one of the free positions of the substituting phenyl, for dehydrothiotoluidine sulphate (3), on heating, can be made to pass into the monosulphonic acid (4) by the migration of the sulphonic acid group, though the exact position of the sulphonic acid group in the phenylated part of the benzothiazole system has not been established. Reasoning by analogy, then, we should expect dehydrothiotoluidine arsenate to be converted into the arsenical compound (5) on heating for a period of time at its melting point or above this.

$$CH_3C_6H_3 <^{S}_{N}> C\ C_6H_4NH_2.H_2SO_4 \longrightarrow$$

(3)

$$CH_3C_6H_3 <^{S}_{N}> C\ C_6H_3(SO_3H)NH_2$$

$$CH_3C_6H_3 <^{S}_{N}> C\ C_6H_4(H_2AsO_3).NH_2$$

(5)

Dehydrothiotoluidine was therefore mixed in suitable proportions with arsenic acid, as described in the experimental part of this paper, and heated at 190° to 200° for three to four hours. The product was hard brown solid, which was insoluble in hot water and caustic soda, but which was extracted as a hydrochloride with hot concentrated hydrochloric acid. The extract, on drowning in water, yielded a precipitate of presumably the hydrochloride, for on the addition of sodium hydroxide or ammonia to this the colour changed from a bright yellow to a very pale yellow solid. The extract was therefore drowned in fairly strong ammonia, when this nearly white amino compound was obtained, which, unlike the original base dehydrothiotoluidine, proved to be insoluble in hot alcohol, and can in fact be boiled in ethyl alcohol without action. The solid dissolved in hydrochloric acid to give a bright yellow orange solution of the hydrochloride; the colour change is assumed to be due to the isomerisation of benzenoid to quinonoid form.

The solution of the hydrochloride was found to be capable of diazotisation, and the diazo solution was found to couple with β naphthol to give a red azo compound, showing the presence of a free amino group in the molecule. The compound gave qualitative tests for arsenic, and would appear to be the compound (6).

The physiological action of a compound such as (6) should prove of particular interest, since here we have the atoxyl structure as the base, which one usually associates with highly marked trypanocidal powers, and further, the double-bonded nitrogen atom of the fused thiazole nucleus, which will clearly modify the action, probably increasing the toxicity of the compound, since one associates the high toxicity of the azo dyes as being intimately connected with the presence of the double-bonded nitrogen atoms of the azo grouping, .N=N. At present, this is, of course, pure speculation, since the structure of the compound has not been proved. Nevertheless it would appear that the Bechamp reaction can, in a modified form, be applied even to such complex amino compounds as 4' amino 1 phenyl 5 methylbenzothiazole. To become familiar with the methods of ar-

senical fusion, the preparation of atoxyl was first studied according to a modification of the usual method. A laboratory preparation of this extremely important compound is also given in the experimental part of this paper.

EXPERIMENTAL.

4 Aminophenyl 1 arsinic acid:

100 gms. of redistilled aniline and 72 gms. of arsenic acid in a finely powdered form are mixed in a 500 cc. flask fitted with *a mechanical stirrer, driven by means of a* small electric motor and secondary batteries. The flask is placed in an oil bath at a temperature of 190° C. The flask is kept at this temperature for a little under two hours, the contents being stirred from time to time by the motor by switching on the current. It is not necessary to stir during the whole two hours, particularly if the motor is driven from secondary batteries. At the end of this time the flask is removed from the oil bath, allowed to cool, transferred to a sand bath, connected with a condenser and the usual apparatus for steam distillation, and steam distilled till nothing further comes over. This removes the unfixed aniline and eliminates the necessity for addition of large quantities of caustic soda. Sodium hydroxide in the minimum of water is then added until the contents of the flask are strongly alkaline, and the steam distillation repeated till nothing further distils. The liquid in the flask is allowed to cool, filtered, and concentrated, then neutralised with strong hydrochloric acid, when the 4 aminophenyl 1 arsinic acid separates on cooling. This can be purified by dissolving in aqueous sodium hydroxide, boiling with animal charcoal, and filtering into alcohol, when atoxyl, the sodium salt, separates in a crystalline form.

Dehydrothiotoluidine: (*J.S.C.I.*, 1923, XLII., 302), *The arsenical fusion*:

1.2 gm. of dehydrothiotoluidine from ethyl alcohol is intimately mixed with 0.7 gm. of arsenic acid. The mixture is placed in a boiling tube and heated in an oil bath at a temperature of 190° to 200° C. for three to four hours. The tube is removed and allowed to cool, and the contents extracted with boiling water to remove any unchanged arsenic acid. The contents, which are in the form of a hard lump, are then extracted with boiling alkali to complete this, and render the contents of the tube filterable. The solid is filtered, dried after a washing, and ground to a fine ochre powder in a mortar. This is extracted with boiling hydrochloric acid in a beaker, and the solution filtered through glass wool. A hard residue remains. The filtrate is then drowned in fairly strong ammonia solution, obtained by adding 880 ammonia to cold water if the product is drowned in water. The bright yellow hydrochloride is obtained. With ammonia the precipitate is nearly white, or pale chrome. The beaker containing the product is then heated to boiling for a few minutes to ensure conversion into the base. The hot liquid is then filtered, and the product washed with hot water to remove salts. The solid is then dried. It was found to be insoluble in boiling alcohol, and gave the qualitative test for arsenic.

Diazotisation and formation of an azo dye with β naphthol:

A small portion of the product described above was dissolved in hydrochloric acid, sodium nitrite added to the cooled solution to form the diazonium salt, and this was coupled with β naphthol in sodium hydroxide when a red azo colour separated. The yield of product purified as above was 1.8 gms.

The Imperial College of Science and Technology, South Kensington, S.W.7.

January, 1924.

GENERAL NOTES.

INFECTION RISKS WITH TELEPHONES.

In view of the statements which have recently been made as to the possibility of the communication of infectious disease through the use of public telephones, the Postmaster-General desires to remind the public that this subject has been investigated on several occasions in the past, both here and in America, and medical experts have declared that there is no real risk in the use of telephones in public call offices, and the alarm raised from time to time has no foundation in fact.

Some time ago, an eminent London bacteriologist conducted a series of tests with telephone mouthpieces which had been in use at busy call offices in Post Offices, rail-

way termini, meat markets, and other places of general resort. The mouthpieces had received no special treatment other than that normally given. The expert's report on these experiments showed that the results were most satisfactory, and that the mouthpieces examined were free from tubercle bacilli. Further tests of a more drastic nature were afterwards made. Telephones were fitted in the wards of a sanatorium and used only by patients in different stages of tuberculosis. The instruments were in use for varying periods, and were not cleaned or disinfected during the course of their experimental use. The subsequent bacteriological examination produced entirely negative results, and the doctor who carried out the experiments stated that he was of opinion that "the transmission of tuberculosis through the medium of the telephone mouthpiece was practically impossible."

It may be observed that a staff of cleaners is permanently employed in looking after the call offices on railway stations and in public places. The call offices are thoroughly cleaned, and the transmitter mouthpieces and receiver caps disinfected at regular intervals of about three days. The cleaning of public call offices situated in residential flats, shops and other private premises is undertaken by the tenants of the premises, while the cleaning of call offices in Post Offices is carried out under the supervision of the Postmaster.

BUREAU OF CHEMICAL ABSTRACTS.

As already announced, the Bureau of Chemical Abstracts was formed in the latter part of 1923, as the result of a joint agreement between the Councils of the Chemical Society and the Society of Chemical Industry, with the object of co-ordinating and, if possible, unifying the abstracts hitherto published separately by the two Societies. The work of the Bureau is in the hands of a Committee consisting of four representatives from each Society, with Prof. J. C. Philip as Chairman.

The Bureau was, at an early stage, called upon to deal with the position created by the resignation, through ill-health, of Mr. A. J. Greenaway, who was connected, for a long period of years, with the publications of the Chemical Society. His experience, fortunately, is at the disposal of the Bureau in its reorganisation of the production of abstracts.

The Bureau has now arranged for a single homogeneous editorial staff, which will, in future, be responsible for the preparation and production of the abstracts, both in pure and applied chemistry. The chief Editor, who will be responsible for the organisation of the scheme and the general control of the abstracts, is Mr. T. F. Burton, who for the past nine years has been Editor of the Transactions and Abstracts issued by the Society of Chemical Industry.

The further decision has been reached that the abstracts in each particular section should, as far as possible, come under the review of an Assistant Editor, with special knowledge of the subjects covered by the section. The Bureau has, accordingly, appointed the following as Assistnat Editors: H. M. Dawson (General and Physical Chemistry), A. A. Eldridge (Inorganic and Analytical Chemistry), W. E. Garner (General and Physical Chemistry), H. J. Page (Biochemistry), E. H. Rodd (Organic Chemistry, aromatic division), A. Shonk (Applied Chemistry), E. E. Turner (Organic Chemistry, heterocyclic division), H. Wren (Organic Chemistry, aliphatic division).

It is felt that this move in the direction of securing unity in editorial and technical control represents a distinct step towards the achievement of the objects of the Bureau.

PROCEEDINGS AND NOTICES OF SOCIETIES.

THE ROYAL SOCIETY.

THURSDAY, FEBRUARY 7.

Papers read:—

G. UDNY YULE, F.R.S.: *A Mathematical Theory of Evolution based on the Conclusions of Dr. F. C. Willis, F.R.S.*

An attempt is made mathematically to develop the consequences of the mutationa view of evolution. The fundamenta assumptions are that: (1) Within any species, in any interval of time, an "accident" may happen that brings about "specific mutation," *i.e.*, the throwing of a new form, regarded as a new species within same genus; (2) Within any genus

in any interval of time, an "accident" may happen that brings about "generic mutation," *i.e.*, the throwing of a new form so different from the parent that it will be placed in a new genus. Both chances are taken as invariable within the group considered and constant for all time.

Sections I.-III. of the paper led up to the expression for frequency-distribution of size of genus at any given time. In Section IV. the expression found is tested on data for four cases, and found to give very good agreement with facts. It is pointed out that there are serious difficulties of interpretation.

In Section V. frequency-distributions of age for genera of a given size are determined. Approximately for large genera ater infinite time, the mean age varies as *logarithm of number of species*, but the dispersion is considerable. When time is limited, the distribution must be regarded as compound, primordial and derived genera forming distinct groups.

Finally, in Section VI., an attempt is made to estimate the doubling period for species in flowering plants, which is placed at probably some two or three million years, present rate of production of specific mutations probably lying between 1 in 15 and 1 in 30 years, among all flowering plants on whole surface of Globe.

L. B. Winter and W. Smith. *Studies on Carbohydrate Metabolism. I.—Variations in the Nature of the Blood Sugar.* Communicated by Prof. F. G. Hopkins, F.R.S.

It has been shown by a method previously described that marked differences exist between the blood sugar of normal persons and those suffering from diabetes mellitus. The sugar was extracted from considerable quantities of blood and a comparison made between the observed optical rotation (P) and that calculated from the reducing power of the carbohydrate, on the basis that glucose is the only reducing substance present. The latter factor is referred to as C. An examination of the variations which ensue under different conditions has been undertaken.

In diabetic cases the value of P is usually greater than that of C. This value is increased as a result of mild hydrolysis with weak HCl, whereas the value of C is unaltered. This may be evidence for the existence of complex sugars in diabetic blood. Similar substances are present in the blood of rabbits after injection of either adrenaline or thyroid alone. Injection of thyroid and adrenaline together usually causes an increase in the total blood sugar, but no change from the normal. The value of P is low and complex sugars are absent.

Papers read in title only:—

J. W. Pickering, D.Sc., and J. A. Hewitt, Ph.D. *The Action of "Peptone" and of Nucleic Acids on the Coagulability of the Blood.* Communicated by Prof. W. N. Halliburton, F.R.S.

Intravascular injection of Witte's "peptone" into tortoises deprived of hepatic activity inhibits coagulation of blood subsequently shed. Addition of moderate concentrations of "peptone" to blood of the tortoise *in vitro* causes prolonged inhibition of clotting, provided the blood has not been in contact with damaged tissues. The anti-coagulant action of "peptone" on circulating blood of pigmented rats is as great in animals deprived of hepatic circulation as in those in which the liver is fully active. "Peptone" has little or no anti-coagulant action *in vitro* on the blood of pigmented rats. Partly pigmented rats are more resistant to the anti-coagulant action of peptone and to its toxic effect on the heart han are animals with completely pigmented fur. Albino rats are still more resistant to these actions.

Reasons are given for the suggestion that variations in surface conditions of blood of one animal from those of another may account for the toxic effect following intravenous infection of heterologous blood. Dogs exhibit wide variations in their susceptibility to anti-coagulant action of peptone. Such action has been demonstrated in animals deprived of hepatic activity.

The rapid intravascular injection or addition *in vitro* of thymus or yeast nucleic acids inhibits coagulation of blood shed from cats and rats which have been deprived of hepatic activity. Serial intravascular injections of thymus nucleic acid into cats or rats deprived of hepatic activity produce hypercoagulability followed by tolerance, culminating in immunity to the anti-coagulant action of nucleic acid. Immunisation can be produced with material free from protein. Anti-coagulant action of thymus nucleic acid is exhibited during the presence and absence of platelets.

Reasons are given for rejecting current views on inhibition of clotting by nucleic

acid. It is suggested that nucleic acid acts by union with plasma components, forming a more stable complex than that existent in normal circulating blood.

E. C. GRAY. *The Latent Fermenting Powers of Bacteria. Parts I., II., and III.* Communicated by Prof. A. Harden, F.R.S.

The experiments described in this series of communications suggest a simple theory of fermentation. There cannot be a host of essentially different enzymes. The mechanism by which succinic acid is split into two parts cannot differ fundamentally from the mechanism by which glucose is split into two parts to form lactic acid, or three parts to form acetic acid, or into two parts to form a mixture of succinic acid and acetic acid or alcohol. It is not conceivable that the addition of formates can change one enzyme into another, as the lactic-acid-forming enzyme into an acetic-acid-forming enzyme, unless both have a common basis.

THURSDAY, FEBRUARY 14.

Papers read:—

DR. C. CHREE, F.R.S., and R. E. WATSON. *Atmospheric Pollution and Potential Gradient at Kew Observatory,* 1921 *and* 1922.

E. WILSON and E. F. HERROUN. *On the Electrical Conductivity of Magnetite.* Communicated by Prof. O. W. Richardson, F.R.S.

C. E. T. MANN. *The Determination of Coefficients of Diffusion in Gels by means of Chemical Analysis, and a Comparison of Results obtained from those yielded by the Indicator Method.* Communicated by W. B. Hardy, Sec.R.S.

C. E. P. BROOKE. *The Difference-Periodogram. A Method for the Rapid Determination of Short Periodicities.* Communicated by Dr. G. C. Simpson, F.R.S.

J. PROUDMAN and A. T. DOODSON. *The Principal Constituent of the Tides of the North Sea.* Communicated by Prof. H. Lamb, F.R.S.

D. H. BANGHAM and F. P. BURT. *The Behaviour of Gases in Contact with Glass Surfaces.* Communicated by Prof. H. B. Dixon, F.R.S.

THE ROYAL INSTITUTION OF GREAT BRITAIN.

The Friday evening discourse on Feb. 1[illegible] (at 9 o'clock) will be delivered by J. H. JEANS, LL.D., D.Sc., F.R.S., on *The Origin of the Solar System.*

On Tuesday, Feb. 12, PROF. JOSEPH BARCROFT, F.R.S., gave a lecture on *The Respiratory Pigments in Animal Life and Their Significance.*

On Thursday, Feb. 14, SIR WILLIAM BRAGG, D.Sc., F.R.S., gave his second lecture on *Crystalline Structure of Organic Substances.*

A General Meeting of the members of the Royal Institution was held on February 4, Sir James Crichton-Browne, Treasurer and Vice-President, in the chair. Lord Boston, Mrs. Goodbody, Colonel Lyons, Miss Emily Martin, Sir George Scott Moncrieff, Mr. A. Cressy Morrison, Lord Riddell, Miss Robertson, Captain Edward Spencer-Churchill, The Hon. David Tennant, Mr. J. F. Thorpe and Major W. S. Tucker were elected members.

THE CHEMICAL SOCIETY.

Papers read at the Ordinary Scientific Meeting, February 7:—

Abnormal Benzene Derivatives, by N. V. SIDGWICK and R. K. CALLOW.

The paper summarised the results of investigations on this subject. Abnormality, *i.e.*, large differences between the isomerides in vapour pressure, and in solubility in the liquid state, requires that there should be two active substituents, and that one of these should be either: (*a*) OH; (*b*) NH_2 or substituted NH_2; or (*c*) CO_2H. The nature of the abnormality is different in cases (*a*), (*b*) and (*c*). With (*a*) the phenols, the ortho compound is always more volatile, more soluble in benzene, and less soluble in water, than the meta and para, which resemble one another closely; that is, the ortho is far less polar (probably less associated). Comparison of the properties of normal and abnormal groups shows that the abnormality is mainly in the ortho series. The results and the cryoscopic work of Auwers (*Z. physikal. Chem.*, XVIII., 595; XXX., 300; XLII., 513) indicate that the

introduction of an active group into a phenol, in the ortho position, makes it highly non-polar, in the meta and para macks it rather more polar, while if it is introduced into the solvent, then in this solvent the para-compounds appear to be less associated. All these facts can be explained by supposing that an active group is one which can co-ordinate with the hydroxyl hydrogen. (1) In the ortho position it will form a stable ring. In the meta or para positions it cannot do this, but will join to the hydroxyl of another molecule (though *to a less extent), increasing the association* or polarity of the phenol. In the solvent, it will co-ordinate with a *m*- or *p*-substituted solute, thus diminishing its association. This explains the non-polarity of the ortho series, and the absence of compounds of *o*-nitrophenol with amines, as well as the fact that in an *o*-*p*-di-substituted phenol the influence of the *ortho* substituent predominates. The behaviour of the acids and amines show many differences from the phenols, and from one another. The acids cannot form stable 5- and 6-ring compounds; the amines, though the formula admits of this, do not seem to co-ordinate in this way unless they are negatively substituted, *e.g.*, chloro- and nitro-anilines.

The Solubility of the Aminophenols, by N. V. SIDGWICK and R. K. CALLOW.

The solubility-curves of the isomeric aminophenols in water, and in benzene, were determined, and their volatilities were compared. Only the *meta* compound forms two layers with these solvents; with water, the two-liquid system is metastable, and lies 60° below the solid-liquid curve.

The aminophenols are abnormal, but their abnormality is not of the usual type; the meta compound is more soluble in water, and less soluble in benzene than would be expected.

The Activity of Hydrogen Ion in Aqueous Solutions of Hydrofluoric Acid, by W. F. K. W. JONES and L. J. HUDLESTON.

The e.m.f. of cells of the type:

H_2 | HF | KCl (sat.) HgCl | Hg

have been measured with concentrations of the acid, ranging from 0.030 to 1.55 N. The activity of the hydrogen ion of the acid has been calculated at these concentrations, assuming that the potential at the liquid junction has been annulled by the saturated potassium chloride solution. The tions of the hydrion calculated by Davies and Hudleston from experiments on conductivity and transference number. The two sets of values agree within the limits of experimental error up to 0.4 N solution, after which the activity is found to be materially higher than the concentration.

The Conductivity and Ionisation of Solutions of Potassium Iodide in Nitromethane, by J. C. PHILIP and H. B. OAKLEY.

This work is a study of the bearing of the factors—temperature, viscosity, concentration—on conductivity and ionisation. The solutions examined were those of potassium iodide in nitromethane at dilutions up to V = 10,000 and over the temperature range 0.85°. In work on the conductivity of non-aqueous solutions much uncertainty arises in connection with the evaluation of Λ_∞ and large discrepancies exist between the figures reached by different investigators. The measurements now recorded indicate that the linear relationship between the equivalent conductivity and the cube root of the concentration ceases to be valid at the highest dilutions. An attempt has accordingly been made to arrive at the value of Λ_∞ for the various temperatures by Washburn's method (*J. Amer. Chem. Soc.*, 1918, XL., 122), which assumes the validity of the mass action law at extreme dilutions. From the values of Λ_∞ obtained in this way the values of α, the degree of ionisation, have been worked out for the concentrations employed at each of the experimental temperatures. It is found that α decreases markedly with rise of temperature. At the dilution V = 200, for example, α diminishes from 0.82 at 0° to 0.76 at 85°. Measurements of the viscosity η of nitromethane were carried out at the same temperatures as those at which conductivity determinations were made, and it was found that the value of Λ_∞ increased with rising temperature in almost exact proportion to the fluidity. The value of the product $\Lambda_\infty \times \eta$ is 0.76 at 0° and 0.73 at 85°.

The Solubility of Aniline Sulphonic Acids, by J. C. PHILIP and R. S. COLBORNE.

Aniline and bromaniline sulphonic acids are characterised by separating from their aqueous solutions in unstable forms, which in some instances are sufficiently persistent to permit the determination of their solubility at a series of temperatures. The

have been studied for aniline *o*- and *m*-sulphonic acids and *p*-bromaniline *o*- and *m*-sulphonic acids. When *p*-bromaniline *m*-sulphonic acid separates from aqueous solution, either on cooling a solution saturated at a higher temperature, or by the addition of mineral acid to a solution of its sodium salt, it yields a felted mass of crystals of a labile monohydrate. When the separation is complete, the containing vessel can be inverted without loss of liquid. On standing, the more stable and therefore less soluble anhydrous acid gradually forms at a number of nuclear points, and the felted mass is ultimately replaced by a small quantity of compact crystals. The changes observed resemble those described by Chattaway for the production and transformation of the labile hexahydrate of calcium tartrate. This same acid in the anhydrous form is obtainable in two enantiotropic modifications — monoclinic and rhombic — although it is only above 100° that the rhombic variety is the stable one. For the whole range of temperature, up to 85°, over which determinations were made the rhombic form was found to be the more soluble.

Mercuration of Nitrohydroxybenazldehydes, by T. A. HENRY and T. M. SHARP.

A mercury derivative of *m*-hydroxybenzaldehyde previously described was shown to be 2-acetoxymercuri-3-hydroxybenzaldehyde,

$$CH_3.CO.O.Hg.C_6H_3(OH).CHO.$$

The three nitrobenzaldehydes do not mercurate even on boiling in solution with mercuric acetate for three weeks. Under similar conditions 3-nitro-4-hydroxybenzaldehyde mercurates in position 5, as is shown by the conversion of the resulting mercury compound into 5-iodo-3-nitro-4-hydroxybenzaldehyde by the action of iodine. 6-Nitro-, 4-nitro-, and 2-nitro-*m*-hydroxybenzaldehydes all yield both mono- and di- mercurated compounds, which can be separated by fractional crystallisation from appropriate fatty acids, the only media in which they are conveniently soluble. They react with iodine in potassium iodide, forming iodo-compounds in which iodine has replaced mercury residues. Bromine, on the contrary, shows abnormal behaviour towards them. Thus, whilst 2:4-dihydroxydimercuri - 6 - nitro -3 - hydrobenzaldehyde yields the expected 2:4-dibromo-6-nitro-3-hydroxybenzaldehyde, the latter is also formed in 80 per cent. yields by the action of bromine on the dimercurated derivatives of the 4-nitro- and 2-nitro-*m*-hydroxybenzaldehydes. It was shown that a rearrangement took place of groups within the molecule, involving the migration of a nitro-group from an ortho- to a para- position with respect to the hydroxyl group. Results of bacteriocidal trials with the mercury compounds were given.

THE ROYAL SOCIETY OF ARTS.

On Wednesday, February 13, at the Ordinary Meeting, a paper entitled *The Preservation of Timber Roofs from the Death Watch Beetle* was read by H. MAXWELL-LEFROY, M.A., Professor of Entomology, Imperial College of Science and Technology. Sir Aston Webb, K.C.V.O., C.B., P.R.A., presided.

On Friday, February 15, at a meeting of the Indian Section, a paper entitled *Salt Manufacture in India* was read by SIR RICHARD M. DANE, K.C.I.E., Commissioner, North India Salt Revenue, 1898-1907, and Inspector-General of Excise and Salt for India, 1907-1909. The Rt. Hon. Lord Meston, K.C.S.I., LL.D., presided.

THE OPTICAL SOCIETY.

The Annual General Meeting for the presentation of reports and the election of office-bearers was held at the Imperial College, Imperial Institute Road, South Kensington, on Thursday, February 14.

Immediately after the Annual General Meeting, an Ordinary Meeting of the Society was held.

The following communications were presented and discussed:—

The Addition of Aberrations, by MR. T. SMITH, M.A., F.INST.P.

The Choice of Wave-lengths for Achromatism in Telescopes, by LT.-COL. J. W. GIFFORD, F.R.A.S.

A New Form of Corneal Microscope, by MR. E. F. FINCHAM.

By the kind permission of Messrs. Cooke, Troughton and Simms, Ltd., and of Col. H. G. Lyons, F.R.S., Director of the Science Museum, South Kensington, the Troughton Dividing Engine (1793) was exhibited and described by Mr. David Baxandall, A.R.C.S.

THE INSTITUTION OF ELECTRICAL ENGINEERS.

A Joint Meeting with the Physical Society of London, in the Lecture Theatre of the Institution, was held on Thursday, February 14.

Atmospherics and Their Effect on Wireless Receivers, by E. B. MOULLIN, M.A.

The paper contains a mathematical analysis of the effect of an atmospheric upon a wireless receiver. The choice of functions representing the atmospheric has been governed by information contained in *Proceedings of the Royal Society*, A, vol. CIII. The effect of each of several wave-forms is calculated and the results are compared. The effect is calculated of an atmospheric acting respectively on a tuned antenna, an aperiodic antenna, on a tuned loop aerial, and also the combination of each of these with a selective amplifier. In each case a formula is derived which gives the ratio of signal to atmospheric, and it is shown that for a given wave-length these formulæ are identical. The possible advantage to be got from the use of an aperiodic antenna or o a slightly distuned periodic circuit is considered in detail. Finally, the rectified current produced by the atmospheric is compared with that produced by the signal, and it is shown that the decrement of the aerial should always be reduced to the point where ringing or bad shaping of signals commences.

THE INSTITUTE OF METALS.

The Annual General Meeting of the Institute of Metals, will be held at the Institution of Mechanical Engineers, Storey's Gate, Westminster, on Wednesday and Thursday, March 12 and 13, commencing each day at 10.30 a.m. The Presidential Address will be delivered by Professor T. Turner, M.Sc., A.R.S.M., in the morning of March 12. No fewer than fourteen communications—many of a very important character—are due for presentation and discussion at the meeting.

In connection with the forthcoming meeting a ballot for the election of members and student members will be taken on February 28.

It is of interest to note—for the first time in the Institute's history—the membership passed the 1,500 mark on December 31, 1923. It is hoped by the Council that, as a result of the many activities of the Institute during the present year—particularly in connection with the British Empire Exhibition—this figure will be substantially increased before the end of 1924.

THE INSTITUTION OF PETROLEUM TECHNOLOGISTS.

The Seventy-Sixth General Meeting was held on Tuesday, February 12. The following paper was read:—

Electricity Applied to the Winning of Crude Petroleum, with special reference to the Yenangyoung Field, Burma, by C. H. MCCARTHY-JONES, M.I.MECH.E., M.I.E.E., M.INST.P.T.

The chair was taken by the President, H. Barringer, M.Inst.C.E., M.I.Mech.E., M.I.N.A., M.Inst.Mar.Eng.

THE GEOLOGICAL SOCIETY.

JANUARY 23, 1924, PROF. A. C. SEWARD, SC.D., F.R.S., PRESIDENT, IN THE CHAIR.

The following communications were read:—

On a Hybodont Shark (TRISTYCHIUS) *from the Calciferous Sandstone Series of Eskdale, Dumfries-shire*, by ARTHUR SMITH WOODWARD, LL.D., F.R.S., F.L.S., F.G.S.

On a Recently Discovered Breccia-Bed underlying Nechells (Birmingham), and its Relations to the Red Rocks of the District, by PROF. WILLIAM S. BOULTON, D.Sc., F.G.S.

An Ordinary Meeting was held on Wednesday, February 6, when the following communication was read:—

The Upper Towy Drainage-System, by PROF. O. T. JONES, M.A., D.Sc., F.G.S.

THE SIR JOHN CASS TECHNICAL INSTITUTE.

ANNUAL DISTRIBUTION OF PRIZES.

On Wednesday, January 30, the annual distribution of prizes and certificates took place at the Sir John Cass Institute. The chair was taken by the Rev. J. F. Marr, M.A., Chairman of the governing body.

In a speech on the work of the Institute

during the past year, the Rev. Marr pointed out the amount of research work that had been conducted in the various departments. The number of original memoirs published by the students and members of the staff during the session amounted to seventeen.

After the Chairman's speech, Sir William Bragg, F.R.S., Director of the Royal Institution, presented the Institute prizes and certificates to those students who had been successful in the past session.

Sir William then delivered his lecture on "Research Work and its Applications."

In this lecture, Sir William pointed out the various applications of research work: Research work was a very valuable training for the young student who was just entering his career. The disappointments of research and the making of apparatus were just as important in the training of the student as the obtaining of actual results.

Secondly, the lecturer showed the industrial uses of research work. In this connection Sir William paid especial attention to the interest shown in research work by the Admiralty. Even if we wish that the days of war have passed, we must still know as much as other nations, and for this reason special attention must be paid to research work.

Lastly, Sir William pointed out that even if research work was not in itself a religion, it was an attribute to religion. He could not understand the attitude of those people who said that too much was being discovered. This point of view reminded him of a man who would live all his life in one room although there were plenty of doors through which he could go out. In the case of research work we had the fact that the more research there was done, the more there was for other people to do, and not that the more research done the less there was for other people to do.

A vote of thanks, proposed and seconded by two of the governers, was carried unanimously.

After the lecture an exhibition of apparatus for research work and students' work was given in the various departments.

SOUTH LONDON BOTANICAL INSTITUTE.

An interesting exhibition was held at the South London Botanical Institute on Feb. 1. The exhibits included a number of microscopical specimens, dried and growing plants, botanical photographs, books and apparatus and plant chemistry.

Mr. G. R. Titchener showed under polarized light, coumarin extracted from the tonquin bean (*Dipteryx odorata*), and Dr. Stubbs had a similar exhibit of crystals of salicin, which occurs in the bark of various willows and poplars. A number of preparations showing the siliceous skeletons of many diatoms, plants whose living representatives are allied to fresh-water algae and occur commonly in pond water, were ably demonstrated by Mr. J. Sandeman. Mr. J. B. Titchener showed a section through a capitulum of a dandelion; and an interesting section through the stem of a water-lily, showing the idioblasts: internal stellate hairs on the papillose cell-walls of which calcium oxalate is deposited, being excreted as a waste product during the metabolism of the plant. Mr. W. R. Sherrin showed a number of preparations illustrating the comparative anatomy of the leaves of various species of wild British grasses. Mr. E. H. Ellis demonstrated a method of micro-measurement of cells in certain moss leaves by their secondary diffraction spectra. A low-power objective is mounted at the end of the microscope draw tube, to be used in conjunction with an objective of higher power mounted on the nose-piece in the usual way, as in the study of axial figures in petrography. Under the sub-stage condenser a slit is placed and an image of it then focussed on to the object, which must be so arranged that the longitudinal cell-walls are parallel to the image of the slit. The slit image is then focussed with the objectives, and a secondary diffraction spectrum is seen on the left and right hand side of the slit. With an ocular micrometer a reading is taken of the distance between the two red bands and compared with that given by a diffraction grating, the lines of which are a known distance apart. Thus estimating the approximate average width of the cells. Mr. E. Cuzner showed a number of his well-known stereoscopic photomicrographs of seeds, etc., and Mr. A. W. Dennis had a similar exhibit dealing with plants (mosses and lichens), too small for ordinary photography and too large for proper photomicrography.

Dr. Druce gave a lucid demonstration of the methods for detecting the chemical elements commonly encountered in plant material. He also touched upon the chemical examination of soils, experimenting with a specimen of Japanese soil, which was shown to contain a very high iron content and to be relatively poor in humus and organic matter.

The British Museum (Natural History)

exhibited some of their series of excellent publications, including handbooks, guide-books and picture-cards. Amongst the picture-cards, which are in sets, each with an explanatory leaflet, may be mentioned a fine series illustrating the *dispersal of fruits and seeds*. These picture-cards deserve to be more widely known than at present, and indicate the type of excellent work the Museum is doing in this and in other directions. Messrs. Watkins & Doncaster also showed some botanical books and collecting apparatus (vascula, drying-paper, presses, etc.).

A number of plants were shown.

Mr. H. Carter had a collection of British mosses, Mr. W. R. Sherrin a collection of Welsh plants, and Mr. J. E. Lousley a collection of rare plants found during 1923. Miss M. W. Bostock exhibited a collection of British fresh-water plants, and gave a short account of the types represented. They were divided into riverside and marsh plants, and true aquatics. The first was a very wide class, including a number of plants which show few special aquatic characters, such as the Marsh Marigold, the Bog Bean, the Monkey Musk, which fringes our riversides, and the Sedges and river grasses. The second class was dealt with in more detail, and included plants showing special characters adapting them for life in water.

Examples were shown of plants belonging to entirely aquatic orders, *e.g.*, Naiadaceæ. In these cases the plants have usually finely divided leaves, though in some cases they are band-shaped, and in the broad-leaved *Potamogeton*, floating leaves are developed, whose upper surface is shiny and leathery to repel the encroachment of water. The flowers are sometimes borne under water (*Ceratophyllum*), but usually the flower spike projects above the surface. Many orders whose members are mostly terrestrial contain one or more aquatic species. Thus Primulaceæ contains the water violet (*Hottonia*), Gentianaceæ includes *Villarsia*, which resembles a small yellow water-lily, and Ranunculaceæ has the water-buttercups.

In some cases water-buttercups are heterophyllous, showing two types of leaf on one plant. The leaves, which grow under the water, are finely divided (racinate), but those developed after the plant has grown above the water, are broad and flat, floating or aerial leaves. The typical floating leaves have a shining, leathery surface, with large stomata on the upper surface and none at all on the under surface. The Duckweeds are free floating plants. There are four British species of *Lemna*, and allied is *Wollfia arrhiza*, the smallest known British flowering plant, which looks like a dark green speck on a pond. The flowers of Duckweed are very minute and are born at the surface of the water.

Mr. H. S. Redgrove gave a demonstration on a selection of rare plants collected by him in the Greater London area.

New Patents.

This list is specially compiled for *The Chemical News* by Messrs. Rayner & Co., Registered Patent Agents, of 5, Chancery Lane, London, from whom all information relating to Patents, Trade Marks, and Designs can be obtained gratuitously.

Latest Patent Applications.

1944—Bader, W.—Manufacture of aliphatic compounds. Jan. 24.

1991—Harper, W. A.—Production of ammonia. Jan. 24.

1874—Soc. Nationale d'Industrie Chimique en Belgique Soc. Anon.—Process for obtaining sulphurets from alkaline metals. Jan. 23.

1764—Soc. Chimique des Usines du Rhone.—Preparation of stable concentrated solutions of *p*-oxy-*m* acylamino-phenylarsanilic acids. Jan. 22.

Specifications Published this Week.

209441—Weizmann, C., and Blumenfeld, J.—Titanium compounds.

209561—Nicholson, T.—Process for neutralising ammonium sulphate.

196585—Henkel et Cie, and Weber, Dr. W.—Process for treating ammonium chlorids lyes in iron vessels.

209694—Thomas, J., and Scottish Dyes, Ltd.—Chlorination of hydroxyanthraquinones.

Abstract Published this Week.

207476—Dyes.—Soc. of Chemical Industry in Basle, Switzerland.

Anthraquinone derivatives.—Brown vat dyes are obtained by first condensing a derivative of 1:2-naphthoquinone containing a mobile substituent with an *o*-diaminoanthraquinone and then condensing the product with a mono- or di-aminoanthraquinone. According to examples the following components are employed: 3- or 6-brom-1:2-naphthoquinone, 2:3- or 1:2-diaminoanthraquinone, and 1-amino- or 1:5-diaminoanthraquinone.

Messrs. Rayner & Co. will obtain printed copies of the published specifications and abstract only, and forward on post free for the price of 1s. 6d. each.

THE CHEMICAL NEWS,

VOL. CXXVIII. No. 3332

A PART-THEORY OF RADIOACTIVITY.

By F. H. Loring.

The theory of radio-activity in respect of the phenomena of ray-emissions has not been formulated, or even developed in the shape of a working hypothesis—so far as the writer is aware. Notwithstanding this probable fact, a great mass of accurate experimental data has been accumulated in connection with the properties of the radio-atoms; and these atoms have been completely co-ordinated by means of periodic tables—as is well known.

Of especial interest is the rays that are emitted at the moment of atomic change. This is a phenomenon many are familiar with in general, so that no full description of it need be made here; but, since the following treatment of the subject along the lines of a part-theory of radioactivity is based upon these ray-emissions, a few particulars characterising the phenomena will now be given by way of introduction and for the purpose of reference:—

1.—The velocities with which the α-rays emerge from the atoms vary from 0.0456 to 0.0688, that of light (light being taken as 299,860 kilometres per second in a vacuum). The mean figure would be 0.0572.

2.—The velocities with which the β-rays emerge from the atoms vary from 0.29 to 0.957 that of light, giving a mean value of 0.623.

3.—The velocity with which the γ-rays emerge from the atoms is probably that of light, for this radiation *is* "light" of extremely short wave-length: to the order of 0.0000000005 cm. (= 0.05 Angstrom unit).

Notes.—The above figures, representing velocity ratios, are taken from recent tables; but all the gamut of values is not known. Moreover, the light-propagation velocity is often taken as 300,000 kilometres per second in these calculations, instead of the closer figures given above.

Now if the highest α-particle velocity be calculated in terms of miles, it comes out at about $300{,}000 \times 0.6214 \times 0.0688 = 12{,}825$. Similarly, in the case of the β-rays, the value comes out at 178,400 miles.

These velocities are so high, nearly that of light in the instance of the highest-speed β-particles recorded, that the problem at once arises as to the origin of the energy necessary to eject particles having masses of 4.00 and 0.00054 in relative figures on the atomic-weight scale (O=16); the former being the α-particle, which is a doubly-charged helium atom (He^{++}); while the latter is, of course, the β-particle, which is a negative electron of mass 1/1845th that of the hydrogen atom. The mass of the hydrogen atom in grammes is 1.662×10^{-24}, to an exactitude of 1.662 *plus* or *minus* 0.002.

It is to be noted that the mass of the α-particle is about 7,400 times greater than that of the electron, yet the former is ejected with a velocity of 12,825 miles per second, as an extreme case. This is a remarkable fact, and in developing the theory of the atom it should be reckoned with.

Now the Bohr theory of the atom would seem to afford a way out of the dilemma to which these facts are leading. In Bohr's atom the electrons are supposed to be describing orbits round a nuclear system which forms the central structure of every atom. Here a ready means is at hand for accounting for the electrons emerging from the radio-atom at such high speeds as just indicated; for, if they travel very fast in their elliptical and circular orbits, the electrons only need to be deflected from their normal paths to pass out of the atomic system at very great velocities. One might expect the single electron of hydrogen to be easily deflected from its path round the positive nucleus and reveal such high planetary speeds. This, however, does not appear to be the case. This difficulty can be eliminated by introducing other considerations in this particular instance; but what about the α-particle? Does it describe orbits like those Bohr ascribes to the electrons? If it does, here is a difficulty which the Bohr theory does not at present explain, so far as the writer is aware.

However this may be, if the ideas developed by the writer in *The Chemical News* (see Recapitulation in the issue of January 25, 1924, pages 51 to 54) be taken into account, in particular, that the radiation can, in its initial stage, form a closed ring round a positive nucleus, or round a positive part of the atom, then a partial

solution of this problem seems possible, as will be shown presently.

In the paper referred to above, it was suggested that the closed radiation supported the electron so that its vibration, together with the ring- or shell-like radiation emanating therefrom and closing round the *charged nucleus*, *could be dynamically* treated as a system equivalent to that of the orbital theory of Bohr. If this is so, then the positioning of the electron relative to the nucleus can be explained; and, moreover, *an "attachment" of the radiation to* the electron seems to follow in consequence, somewhat as in electromagnetic phenomena.

Now, in the case of radioactivity, the *disturbance giving effect to the issue of* β-rays from the atom arises in the nucleus of the atom. This action of central origin has been proved experimentally by Rutherford and others. Let it now be assumed that the *electron which leaves the atom* has been subjected to a blow directed from the centre of the atom outwards; or, that some equivalent effect, such as a nuclear part sinking towards the centre of the atom has taken place, thereby *freeing the electron from a* local central control. The electron is then free from bondage, or it is driven from its normal place, and being all the while in sympathetic or synchronous vibration with *the encircling radiation*, it is easily wrenched from its position by the mechanism of radiation, which radiation propagates itself, so to speak, with the velocity which characterises it as "light," when free to do so—as *in this case*. The electron, being initially attached to the radiation, it is dragged away from the atom at a velocity approaching that of light in the extreme example indicated.

Thus it will be *seen that*, *according to* this view, the velocity of the electron arises directly from the radiation to which it is initially attahced, setting off at a rate of speed of about 178,400 miles per second.

In the instance of the α-particle, the same process takes place if the theory may be extended, as seems probable; but the wrench, in terms of energy, is much greater because the encircling radiation of a nuclear *unit* (*He++ or its equivalent in 4 protons* and accompanying electrons) is correspondingly greater. The *freeing of this unit* is also due to a disturbance in the core of the atom, which seems to suggest that in the *case of the radio-atoms the nuclear parts* are, to all intents and purposes, built on structures that are more easily detachable.

The energy factors arising in these cases *of the highest-speed α-particle* and the highest-speed β-particle in terms of *drag*, if such an expression be allowed, may, as already indicated, be due to the presence and opening out of the encircling radiation, that is, *proportional to* the electrons initially present. Sir J. J. Thomson has shown by positive-ray experiments that the hydrogen atom (nucleus) can carry two electrons as an extreme case. Taking, therefore, the *extreme speed of the α-particle* as corresponding with 2 electrons per proton (8 electrons), a rough calculation can be made. The velocity of the α-particle, 12,825 miles per second relative to that of the electron *is as* 1 : 13.91; and by *the* kinetic energy formula, $1/2v^2m$, the two cases become:— $1/2(1^2 \times 4) = 2$. $1/2(13.91^2 \times 0.00054) = 0.0522$. Since, however, the mass of the electron increases owing to the relativity *effect*, *the figure*, *representing in* comparative terms the energy of the electron, has to be increased 3.56 times if the speed ratio is 0.957. This correction raises the figure to 0.186. The theoretical value, deduced from *the α-particle energy with 8 electrons* should be $2/8 = 0.250$, which is near enough to illustrate the idea.

Taking now the other extreme of, say, 4 protons and 4 electrons corresponding with *the slowest-speed α-particle recorded*, the ratios should be:—

$$8500^2 : 12825^2 :: 4 : 8.$$

While this relationship is approximately correct, there are 19 intermediate speed *ratios which cannot be brought into* harmony with the various combinations of electrons and protons, as shown thus:—

(8) 2 2 2 2 = highest-speed α-particle.
(7) 2 2 2 1
(6) 2 2 1 1
(5) 2 1 1 1
(4) 1 1 1 1 = lowest-speed α-particle.

It may, however, be assumed that the electron energy varies in about the same general way, so that the possible combinations may be 5^2, but the reason for this variation is not one which seems easy to explain.

This line of study brings the problem here discussed *face to face with the remarkable* property of the free æther which always propagates various wave radiations with a fixed velocity. This is as it should be, for here we have founded a theory on a first *principle, if ever there was one, that* dominates the whole universe. Einstein's theory

of relativity was built upon the constancy of the velocity of light propagation. Here we have the initial creation of kinetic energy by virtue of the radiation velocity, and it looks as if the whole problem of cosmogony should start from this basis; in fact, the whole of energy phenomena perhaps starts here.

SUMMARY.

Following up an idea recently developed in these pages—that radiation at its inception can encircle a positive nuclear part of an atom—it is here suggested that when the nuclear part is in effect eliminated, or the single electrons driven away from their binding nuclei by a blow directed from the core of the atom, the electrons which are bound up with the circular radiation, and produce it by their vibration, are dragged out of the atomic system by the attached radiation which sets off at a velocity characteristic of radiation. The β-particles may, therefore, emerge at a velocity nearly that of light. The α-particles are dragged out with greater energy, owing to their association with a greater quantity of radiation, but their speed is less owing to the mass of the α-particle being much greater than that of an electron, even when allowing for the relativity effect in the case of the latter.

ATTEMPTS TO PREPARE A CYANIDE OF TIN.

BY J. G. F. DRUCE, M.SC. (LOND.), R.NAT.DR. (PRAGUE).

No reference has been found to any investigation having for its object the preparation of the cyanides of tin.

Organo-metallic cyanides of tin have, however, been prepared by Cahours (*Annalen*, 1860, CXIV., 227), and by Cahours and Demarçay (*Compt. Rend.*, 1879, LXXXVIII., 1112), from certain tin alkyl haloids by the action of silver cyanide. In the course of some work involving the preparation of cyano-derivatives of organo-metallic compounds, it was, therefore, thought to be, of interest to endeavour to isolate a simple cyanide of tin.

Very little work also appears to have been done in connection with the cyanides of other metals in the fourth group of the Periodic Classification of the Elements Gupta (*Proc. Chem. Soc.*, 1913, p. 361), and more recently Herz and Neukirch (*Zeitschr. anorg. Chem.*, 1923, CXXX., 343), describe the preparation of lead cyanide. The former states that the precipitate obtained by the interaction of a soluble lead salt and a soluble cyanide, is a basic lead cyanide, the composition of which, he states, varies according to the concentration of the reacting solutions. He therefore isolated pure lead cyanide by dissolving the basic salt in a boiling 5 per cent. solution of hydro-cyanic acid.

Deep yellow crystals separated from the filtrate on cooling. These, on analysis, were found to have the composition corresponding with the formula, $Pb(CN)_2$.

Using normal solutions, Herz and Neukirch showed that lead is precipitated quantitatively as lead cyanide from lead nitrate by excess of sodium cyanide. Solutions of strength 0.2 N. gave low results (owing to the formation of a basic product). These authors suggest that this method constitutes a means of estimating lead quantitatively. In the course of the present work their results have been confirmed.

Although various attempts have been made to obtain a cyanide of tin, none have been successful. The interaction of aqueous, stannous and stannic solutions with potassium cyanide has yielded only precipitates of the hydrated metal oxides. The use of other solvents has also not led to the isolation of a tin cyanide.

The prolonged action of hot dilute hydrocyanic acid on stannic hydrate caused some of this amphoteric hydroxide to dissolve, and may have yielded a basic cyanide of tin.

The action of pure hydro-cyanic acid upon the tin hydrates could not be investigated, but it is doubtful whether this would lead to the preparation of a pure cyanide of tin.

EXPERIMENTAL.

Five gr. of stannous chloride were dissolved in 150 cc. of ether, and about 8 gr. of silver cyanide were added, and the whole heated under a reflux condenser for three hours. The solution was filtered and the filtrate was left in a vacuum desiccator over potash and sulphuric acid for some days. The residue was extracted with alcohol, which was then evaporated off, leaving a pale, brownish film. This substance contained nitrogen and stannic tin, but not stannous. It dissolved in hot alcohol and ether, but not in water. Hot dilute acids

dissolved it without the evolution of hydrocyanic acid. No silver cyanide resulted on adding silver nitrate to the nitric acid solution of the brown residue.

In another experiment, stannous chloride and ethyl cyanide were dissolved together in ether and heated under reflux condenser for several hours. The solvent was then evaporated, but no tin cyanide was obtained.

A solution of stannous chloride in the minimum amount of dilute hydrochloric acid required to prevent hydrolysis was treated with potassium cyanide until alkaline. The precipitate was filtered, washed with warm water several times until the filtrate no longer gave a precipitate with silver nitrate. It was drained and dried. The white residue was soluble in warm dilute nitric acid without the evolution of any hydrocyanic acid, and the addition of silver nitrate gave no precipitate of silver cyanide. A portion of the substance was treated with warm hydrochloric acid, ferrous sulphate was added, and then the whole was boiled with sodium hydrate solution. When acidified and ferric chloride added, there was only a faint blue colour, which indicated the presence of a trace of cyanide.

In other experiments potassium cyanide solution was added to solutions of potassium stanno-chloride and ammonium stanni-chloride. The precipitates obtained were washed with warm water, and when the filtrates no longer gave a precipitate with silver nitrate the residues were drained and dried. On examination these were found to contain no cyanide and consisted of hydrated tin oxides.

More promising results appeared to be possible by dissolving the tin hydroxides in dilute hydrocyanic acid. In the case of the stannic hydrate, some of the solid dissolved in the hot acid. The filtrate was evaporated slowly in a vacuum desiccator over potash, and left a small amount of a pale brown amorphous residue, insoluble in water, alcohol and ether. The substance dissolved in warm dilute acids.

On analysis:

0.1585 gr. gave 0.1204 gr. SnO_2;
Sn = 59.7 per cent.

0.1585 gr. gave 0.1040 gr. AgCN;
CN = 12.7 per cent.

$Sn(OH)_3.CN$ requires Sn = 59.8 and CN = 13.3 per cent.

It is thus possible that a basic stannic cyanide was obtained.

When a large excess of potassium cyanide was added to the various tin solutions, the precipitate first obtained did not dissolve in the excess of the precipitant, so that no double cyanides were formed.

Lead Cyanide.

When a solution of potassium cyanide (7 gr. in 100 cc.) was added in excess to a saturated solution of lead nitrate, a white precipitate of lead cyanide was produced. This was somewhat soluble in boiling 5 per cent. hydrocyanic acid, from which it separated in the form of almost colourless needles.

In a quantitative experiment, 1.4010 gr. of lead foil were dissolved in hot dilute nitric acid, and the solution was carefully concentrated almost to dryness, water was first added and then a slight excess of potassium cyanide solution. The precipitate was collected, washed with cold water, drained and dried at 105°. In this way, 1.5702 gr. of lead cyanide were obtained, which is in good agreement with the theoretical requirements in accordance with the equation:—

$$Pb(NO_3)_2 + 2\,KCN = 2\,KNO_3 + Pb(CN)_2.$$

CRITICAL STUDIES ON METHODS OF ANALYSIS.

V.—Cadmium.

By Leon A. Congdon and Reuben C. Canter.

[*Contribution from the Department of Chemistry, Syracuse University.*]

Introduction.

The literature shows about twenty-five references for the quantitative estimation of cadmium—eleven of which are straight gravimetric ones or modifications, seven are for the electrolytic determination, and seven for the volumetric process or modification. For this study the following eight methods were selected, four of which were gravimetric and four volumetric:—

Meldrum's (1) gravimetric sulphide method, Browning and Jones' (2) gravi-

(1) Meldrum, Robert, *Chem. News*, 1900, LXXIX., 170.

(2) Browning, P. E., and Jones, Louis C., *Chem. News*, 1897, LXXIV., 190.

metric oxide method, Carnot and Proromant's (3) gravimetric pyrophosphate method, the gravimetric sulphate process (4), Von Berg's (5) volumetric iodometric method, Gibb's (6) volumetric permanganate method, Valentine's (7) volumetric arsenic acid indirect iodometric method, and Cernatesco's (8) volumetric thiocyanate process.

PRINCIPLE OF THE METHODS.

Meldrum's gravimetric sulphide method is based npon the fact that cadmium is precipitated quantitatively by hydrogen sulphide, dried at 100° Centigrade, and weighed as the sulphide.

Browning and Jones' gravimetric oxide method depends upon the principle that cadmium is precipitated by K_2CO_3. It is then ignited to the oxide and weighed as such.

Carnot and Proromant's gravimetric pyrophosphate method precipitates the cadmium as cadmium ammonium phosphate at 60° C. The precipitate is then ignited to the pyrophosphate.

The gravimetric sulphate process is an adaptation of the historic $CaSO_4$ process. The substance, such as the chloride, is treated with dilute H_2SO_4, heated, and the cadmium weighed as the sulphate.

Von Berg's volumetric iodometric method titrates the separated cadmium sulphide with standard iodine solution. The equation involved being:—

$$CdS + 2HCl + I_2 = CdCl_2 + 2HI + S.$$

Gibb's volumetric permanganate process depends upon the following reactions:—

$$CdCl_2 + H_2C_2O_4 = CdC_2O_4 + 2HCl;$$
$$5H_2C_2O_4 + 2KMnO_4 + 3H_2SO_4 = 2MnSO_4 + K_2SO_4 + 18\ H_2O + 10\ CO_2.$$

Valentine's volumetric arsenic acid indirect iodometric method is based upon the following equations:—

$$3\ CdCl_2 + 2\ H_3AsO_4 = Cd_3\ (AsO_4)_2 + 6\ HCl;$$
$$Cd_3\ (AsO_4)_2 + 4Na_2S_2O_3 = Cd_3\ (AsO_3)_2 + 2\ Na_2\ S_4\ O_6;$$
$$2\ I_2 + 4\ Na_2S_2O_3 = 4\ NaI + 2\ Na_2S_4O_6.$$
$$\text{Hence: } 3\ Cd = 2\ AsO_4 = 4\ I = 4\ Na_2S_2O_3.$$

Cernatesco's volumetric ammonium or potassium precipitation method is based on the following equations:—

$$CdS + 2\ AgNO_3 = Ag_2S + Cd\ (NO_3)_2;$$
$$Ag\ NO_3 + KSCN = AgSCN + KNO_3;$$
$$3\ KSCN + Fe\ (NO_3)_3 = Fe\ (SCN)_3 + 3\ KNO_3.$$

EXPERIMENTAL.

For the determinations in this comparative study of methods, a sample of $Cd\ Cl_2.2H_2O$ with 0.004 per cent. SO_4, trace of iron, no zinc nor arsenic, having a theoretical percentage of 51.23 per cent. of Cd. was used.

No especial difficulty was encountered with the methods investigated as to getting check results with the same method.

The following observations were noted, however, in regard to some of the methods tried. There is very little to choose between the sulphide and sulphate gravimetric methods except that the sulphate method requires less time when pure salts are examined. The gravimetric oxide method gave results which were generally too low. The gravimetric pyrophosphate method is too technical for a standard method, and even with careful attention the results obtained were entirely too low from the theoretical percentage of cadmium in the samples examined.

The volumetric methods examined were very accurate, but various features as regards time, ease in manipulation, and ease of calculation deserve attention. Of the four volumetric processes tried, P. Von Berg's iodometric method was fonud to be the best for the following reasons: 1st, It was the most accurate; 2nd, required the least time; 3rd, ease in manipulation, such as number of standard solutions necessary, etc.; and 4th, ease of calculation.

In R. Cernatesco's volumetric method great care must be used in getting all the salt precipitated and put into solution again. However, this volumetric method does not require as long a time as Gibb's or Valentine's volumetric methods.

The following table gives the results of this comparative study of methods for the estimation of cadmium.

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(3) Carnot, A., and Proromant, P. M., *Chem. News*, 1885, LII., 42; Winkler, L. W., *Zeit. Angew. Chem.*, 1921, XXXIV., 383-4, 466-7; Austin, Martha, *Amer. Jour. Sci.*, VI., 233; *Chem. News*, 1900, LXXX. 305.

(4) Adapted from the old $CaSO_4$ process.

(5) Von Berg, P., *Zeit. Anal. Chem.*, 1887, XXVI., 23; Enell, H. N., *Zeit. Anal. Chem.*, 1915, LIV., 537-46.

(6) Gibbs, W., *Zeit. Anal. Chem.*, VII., 259; *Ibid.*, X., 343.

(7) Valentine, J., *Zeit. Anal. Chem.*, 1915, LIV., 76-89.

(8) Cernatesco, R., *Bull. Soc. Sci. Acad. Roumaine*, 1922, VIII., 43-46.

Wt. of sample gms.	Method used	Theoretical p.c. of Cd in Sample	P.c. Cd obtained	Average P.c. Cd obtained	Diff. from Theoretical p.c.
0.7602 0.9780	Grav. sulphate *process*	51.23	51.00 50.91	50.96	-0.27
1.2821 1.1901	Meldrum's Grav. Sulphide method	51.23	51.25 51.40	51.32	+0.09
0.7536 1.2072	Browning & Jones' Grav. Oxide method	51.23	49.80 50.00	49.90	-1.33
0.8162 0.7315	Carnot & Proromant's Grav. Pyrophosphate method	51.23	48.80 48.75	48.73	-2.50
0.8205 0.7232	,, ,,		48.71 48.65		
0.6584 0.5366	Von Berg's Volumetric Iodometric process	51.23	51.10 51.00	51.05	-0.18
0.6575 0.5366	Gibbs' volumetric permanganate method	51.23	51.05 51.00	51.03	-0.20
0.7181 0.5801	Valentin's indirect arsenic acid iodometric process	51.23	50.50 50.64	50.57	-0.66
0.5864 0.6351	Cernatesco's volumetric $AgNO_3$ pptn. method	51.23	50.90 50.81	50.86	-0.35

Summary and Conclusions.

1.—Eight different methods of analysis were compared experimentally on a sample of cadmium salt of known purity. Four methods were gravimetric, namely, sulphate process, Meldrum's sulphide method, Browning and Jones' oxide method, and *Carnot and Proromant's pyrophosphate* method. The four volumetric processes compared were Von Berg's iodometric, Gibb's permanganate, Valentin's indirect arsenic acid iodometric, and Cernatesco's silver nitrate precipitation method.

2.—The accuracy of these eight methods may be classed as follows, beginning with the most accurate: Meldrum's gravimetric sulphide method; 2nd, Von Berg's volumetric iodometric process; 3rd, Gibb's volumetric permanganate method; 4th, the gravimetric sulphate method; 5th, Cernatesco's volumetric silver nitrate precipitation process; 6th, Valentin's volumetric indirect arsenic acid iodometric method; 7th, Browning and Jones' gravimetric oxide process; and 8th, Carnot and Proromant's gravimetric pyrophosphate method.

CRITICAL STUDIES ON METHODS OF ANALYSIS.

VI.—Molybdenum.

By Leon A. Congdon and L. V. Rohner.

[*Contribution from the Department of Chemistry, Syracuse University.*]

Introduction.

A perusal of the chemical literature gives about twenty methods or modifications of the methods for the estimation of molybdenum. Eight of the methods are gravi-

metric procedures, one method is a modified electrolytic method, and the remaining eleven references have to do with the volumetric processes. This study takes up the following methods:—(1) The lead molybdate gravimetric process; (2) the gravimetric precipitation process of molybdenum as the sulphide changed to the oxide and weighed as such; (3) the mercurous molybdate gravimetric process; and (4) the volumetric iodometric sodium arsenite method.

PRINCIPLE OF THE METHODS.

The lead molybdate gravimetric method is based on the precipitation of lead molybdate in acetic acid solution by lead acetate. The method is generally known as Chatard's process.

The sulphide-oxide gravimetric process is based on the fact that molybdenum may be estimated by precipitation as the sulphide and conversion of the sulphide into molybdenum trioxide, but the temperature should not be allowed to exceed about 925° C., or the molybdenum trioxide will sublime. The method is really due to Trautmann, but others have worked out important details. It may be known as Trautmann's method.

The Hillebrand mercurous molybdate gravimetric process is based on the precipitation of molybdenum as mercurous molybdate by mercurous nitrate solution and the volatilisation of the mercury, giving subsequent molybdenum trioxide, in which form it is weighed.

The volumetric iodometric sodium arsenite method is based on the fact that when a mixture of molybdic acid and potassium iodide in presence of hydrochloric acid is boiled, the volume having defined limits, free iodine is liberated and expelled, and the molybdic acid reduced to a definite lower oxide. By use of standard oxidising and reducing agents, the molybdic acid is estimated. The reaction in the first case is as follows:—

$$2MoO_3 + 4KI + 4HCl — 2\ MoO_2I + I_2 + 4KCl + 2H_2O.$$

This volumetric process is really due to Mauro and Danesi, although F. A. Gooch and his pupils have worked out many important analytical details of the principle.

EXPERIMENTAL.

For this study of methods, a sample of c.p. salt, $(NH_4)_6\ Mo_7O_{24}\ 4H_2O$, was used. No trace of phosphorus or arsenic was present in the sample.

Difficulty was encountered in some of the methods as regards the checking of duplicate results of each process, and the following table of results shows the accuracy of each process in regard to the theoretical per cent. of MoO_3 in the sample analysed:—

Method used	Wt. sample gms.	P.c. theoretical MoO_3	P.c. MoO_3 obtained	Avge. p.c. MoO_3 obtained	Avge. Diff. from theoretical p.c.
Lead Molyhdate Grav. process	0.6480 0.6051 1.0122	80.66	80.75 80.71 80.61	80.69	+0.03
Sulphide-oxide Grav. method	0.6866 0.9945	80.66	80.51 80.09	80.30	-0.33
Mercurous Molybdate-oxide Grav. method	1.0547 1.2782	80.66	80.98 81.30	81.14	+0.48
Iodometric Vol. process	0.4261 0.4562	80.66	80.68 80.69	80.68	+0.02

(1) Chatard, T. M., *Amer. Jour. Sci.*, 1871, III., 1, 416; *Chem. News*, 1871, XXIV., 175-6; Schindler, Carl, *Chem. News*, 1889, LVIII., 61.

(2) Wolf, K., *Zeit. Angew. Chem.*, 1918, XXXI., 1, 140; Trautmann, W., *Zeit. Angew. Chem.*, 1910, XXIII., 1981; Hoepner, W., and Bender, O., *Chem. Zeit*, 1918, XL.,

suggested by Berzelius, *Pogg. Ann.*, LIII., 124); Hildebrand, W. F., "Analysis of Silicate and Carbonate Rocks," U.S. Geological Survey, Wash., D.C., *Bull.*, 1919, 700, revised from *Bull.*, 1907, 422.

(4) Freidheim & Euler, *Ber.*, 1895, XXVIII., 2066; Gooch, F. A., and Fairbanks, Charlotte, *Amer. Jour. Sci.*, (4), II., 156-60; oGoch, F. A., and Pulman, Jr. O.

This table of results shows that the sulphide-oxide gravimetric method did not give results concordant with each other, due, perhaps, to the slight volatilisation of the oxide at even the temperature of the Bunsen burner. The average result by this method also shows the method gives about 0.3 per cent. lower than theoretical.

The mercurous molybdate-oxide gravimetric method gives results too high and also not concordant results in duplicate, due to the non-practicability of volatilising all the mercury. If Cr, W, V, As, or P are present in sample, they must be separated from the solution.

The lead molybdate gravimetric process and also the iodometric volumetric method are very accurate for the estimation of molybdenum, the volumetric process being the most accurate. For general work, the lead molybdate gravimetric process is best, especially where other substances interfere in an oxidation or reduction volumetric process.

Summary and Conclusions.

1.—Four methods for the analysis of molybdenum were experimentally compared as to their accuracy on a sample of c.p. salt, $(NH_4)_6Mo_7O_{24}4H_2O$, namely, Chatard's gravimetric process, Trautmann's gravimetric process, Hillebrand's mercurous molybdate-oxide gravimetric method, and Mauro and Danesi's volumetric iodometric process modified by Gooch and his students.

2.—The accuracy of the methods examined may be classified as follows:—1st, Mauro and Danesi's volumetric iodometric; 2nd, Chatard's gravimetric lead molybdate; 3rd, Trautmann's gravimetric sulphide-oxide; and 4th, Hillebrand's mercurous molybdate-oxide process.

3.—For ordinary analytical work, Chatard's gravimetric lead molybdate process is the most convenient, and is extremely accurate.

GENERAL NOTES.

FACTS ABOUT PEAT.

The widespread and general interest in the possibility of utilising the extensive peat deposits of Canada as a source of fuel for domestic and other purposes had led to the publication by the Mines Branch of the Federal Department of Mines of a Bulletin entitled "*Facts about Peat.*"

The present publication, which is comprised within 48 pages and written in non-technical language, aims, as its size and title indicate, to present in "tabloid" form the outstanding facts in relation to the peat resources of Canada and their possibilities as a source of fuel.

The Bulletin indicates briefly the nature of peat, the difficulties involved in the production of fuel from it, and the underlying principles upon which any successful attempt at manufacturing must be based. A short account is given of unsuccessful efforts made in the past in Canada, and of the methods which were experimented with. The possibilities of removal of water from peat by pressure, evaporation by artificial drying, briquetting, carbonisation and recovery of by-products are discussed. The air-dried-machine peat process, the only process which has so far been employed successfully on a large scale, is described, and the character and value of the fuel manufactured according to this process are discussed, and a number of opinions of users quoted. Other uses of peat are briefly dealt with. Detailed information relating to Canadian peat bogs so far investigated is summarised in tabular form. Tables relating to the production of peat fuel in Canada and other countries are appended, and a short bibliography is included, indicating the principal sources of information on which the bulletin is based.

Since it is probable that the peat resources of Ontario and Quebec may in the near future assist materially in coping with the fuel problem in the acute fuel area of these provinces, the appearance of this Bulletin is timely and should prove of wide interest.

Copies of this Bulletin (Mines Branch Report No. 614) may be obtained on application to the Director, Mines Branch, Department of Mines, Ottawa.

FRANCE'S OUTPUT OF POTASH.

Mr. J. R. Cahill, H.M. Commercial Counsellor at Paris, reports that, according to the *Information Financiere* of February 7, the output of Alsatian potash during the year 1923 was as follows:—

	Metric tons.
Sylvinite 12/16 p.c.	409,565
Sylvinite 20/22 p.c.	348,044
Chloride 30/40 p.c.	110,153
Chloride 50/60 p.c.	159,278
Total	1,026,042
Pure potash	248,528

In 1923 there was an increase of about 20 per cent. in the output reckoned in pure potash, and of more than 21 per cent. in the output of crude salts. The increase is particularly noticeable as regards chlorides, amounting to 25 per cent. in respect of chlorides with a content of 50 to 60 per cent., and of nearly 85 per cent. for those with a lower content.

PARIS COMPANY ORDER BOILERS FOR PULVERISED FUEL FIRING.

The Union d'Electricité, which has power stations at Gennevilliers and Vitry, near Paris, for the supply of electric power to the city and its environs, has placed another large order for pulverised fuel plant with the company associated with Vickers and International Combustion Engineering, Ltd., of London. It is for the power station at Gennevilliers.

For the new extension the engineers of the Union d'Electricité have decided upon Ladd-Belleville boilers and Lopulco plant for pulverised fuel firing. This decision is significant in view of the fact that the mechanical stokers already working in the station represent the very last word in modern practice.

One of the companies associated with Vickers and International Combustion Engineering, Ltd., has received a contract to equip the new power plant of the Societé Metallurgique de Hoboken, near Antwerp, with boilers arranged to use pulverised coal and Lopulco equipment.

This is the second large order recently placed in Belgium for such plant, the other being for a power station at Charbonnages de Beeringen in Limbourg.

DYESTUFFS (IMPORT REGULATION) ACT, 1920.

Applications for Licences in January, 1924.

The following statement relating to applications for licences under the Dyestuffs (Import Regulation) Act, 1920, made during January, has been furnished to the Board of Trade by the Dyestuffs Advisory Licensing Committee.

The total number of applications received during the month was 441, of which 377 were from merchants or importers. To these should be added 17 cases outstanding on January 1, making a total for the month of 458. These were dealt with as follows:

Granted—363 (of which 340 were dealt with within 7 days of receipt).

Referred to British makers of similar products—52 (of which 41 were dealt *with within 7 days of receipt).*

Referred to Reparation Supplies available—8 (all dealt with within two days of receipt).

Outstanding on January 31, 1924—35 (mostly dealt with at the meeting of the Committee, held February 1).

Of the total of 458 applications received, 389, or 85 per cent., were dealt with within 7 days of receipt.

"It is of interest to note that the long periods of 18 elements in the periodic table appear to involve very small changes of the value of the ionisation potentials throughout the middle of their length, and the rare earths are not likely to have values that differ much from one another. . . Attention might be called, for instance, to the geneeral distribution of the majority of the lines in the spectrum of an element, as an indication of its probable ionisation potential. It is thus perfectly plain on inspection that the ionisation potentials of Be, B and C must be fairly high, and that Fe, Ni and Co cannot differ much from one another, and the values of their potentials must be moderate. Col. I., all lines are pairs; Col. II., they are singlets or triplets; Col. III., they are pairs or quadruplicates; Col. IV., they are singlets, triplets, or quintuplicates; and so forth in a regular manner, alternating and increasing across the table."—F. A. Saunders, *Science*, January 18, 1924.

SPECTRA OF METEOR TRAINS AND AFTER-GLOW IN GASES.

Knowledge on some obscure laboratory phenomenon is often obtained by the study of occurrences in regions far removed from those near at hand, or *vice versa*. An example of this kind is afforded by a paper written by Miss Mabel Weil, who worked with the late Prof. C. C. Trowbridge. The following is an abstract of this paper, which appeared in the *Proceedings of the National Academy of Sciences*, of January, 1924, p. 24. Prof. Trowbridge had prepared the material, and the communication appears under his name.

A number of observers have recorded their investigations and made observations respecting the nature of the luminous trails of meteors. It appears that these trails sometimes persist for several minutes, or even for an hour before fading out. Prof. Trowbridge held the view that this phenomenon was due to the phosphorescent after-glow of the gas under conditions of extremely low atmospheric pressure. After-glow in *gases is known to persist for several* minutes, and to take place at very low temperatures comparable with those at high altitudes—say, 50 to 60 miles where meteor trains are seen.

The investigations bearing on the spectra of meteor trains date back to 1866, when A. Herschel and J. Browning made certain observations. Then followed Secchi, 1868; von Konkoly, 1872 to 1879; Pickering, 1897; Blajko, 1904.

The spectrum of the after-glow in nitrogen was studied by E. P. Lewis (1900), by C. C. Trowbridge (1906), and by Fowler and Strutt (1911). Bergen Davis qualitatively studied the after-glow in helium in 1905.

Many of the early observations seem quite *unreliable, and it was not until Pickering* took the matter up that reliable spectroscopic data began to appear. Mayll (1904) observed 10 lines in the ultra-violet, the same region photographed by Pickering, while Blajko identified some of the lines that he photographed with those of helium, but his identifications were not exact, being out by about 12 units.

Sir Wm. Ramsay had examined some plates taken by Pickering, but Ramsay also failed to identify the lines.

The author of this paper, as presented by Miss Weil, remarks that—"Meteor trains resemble in several respects the phosphorescent after-glow of nitrogen and other gases. The properties of the after-glow of various elements have been studied, but as regards spectroscopic measurements, attention has been given principally to nitrogen." *The after-glow of nitrogen was studied spec*troscopically, as stated above.

Referring to Strutt and Fowler's investigations on nitrogen, "they reached the conclusions that the after-glow contains some of the same bands as the nitrogen spectrum, but that the intensities are different. 'Apart from the modification of intensities, for which we can offer no explanation at present, this observation is in accordance with the view that nitrogen is partially dissociated in the condensed discharge, and that the after-glow is produced during the re-formation of ordinary nitrogen.'"

Oxygen gives a continuous spectrum, and H. Hertz found that hydrogen gives at least 10 lines between the green and violet. Davis, working with helium in 1905, appears to have obtained an after-glow spectrum of 6 lines, one red, one yellow, one green, and three in the blue. The yellow *line was most persistent, and the red line* came next in this respect. The others disappeared almost instantly.

The following table shows some of the approximate relationships given in this paper:—

After-glow.	Meteor train.
3572.9	—
3584.7	3573.
3789.3	3802.9
3101.9	—
—	4027.0
4028.7	4042.5
4042.8	4066.0

The investigator in the case of the above meteor train lines was Blajko.

The paper concludes with a long and useful list of references and short notes to each as to its nature. F.H.L.

PROCEEDINGS AND NOTICES OF SOCIETIES.

THE ROYAL SOCIETY.

THURSDAY, FEBRUARY 14.

Papers read:—

DR. C. CHREE, F.R.S., and R. E. WAT- son: Atmospheric Pollution and Potential

Gradient at Kew Observatory, 1921 and 1922.

The paper dealt with results for atmospheric pollution and potential gradient derived from recording instruments at Kew Observatory during 1921 and 1922. The pollution results were obtained from one of Dr. Owens' pollution recorders, while the potential gradient results were obtained from the records of the Kelvin water-dropping electrograph. It is found that absolute values of pollution and potential in general increase together, also that the range of the regular diurnal variation of potential gradient is larger on days of high than on days of low pollution.

The diurnal inequalities chiefly employed were based on the 10 selected days a month used in the ordinary course for the Kew annual tables. The 10 days were divided into two equal groups, the one composed of the days of higher, the other of the days of lower pollution. Pollution and potential gradient inequalities were then found separately for the two groups.

E. Wilson and E. F. Herroun. *On the Electrical Conductivity of Magnetite.* Communicated by Prof. O. W. Richardson, F.R.S.

The communication records experimental results obtained in an investigation of the effects of impressed voltage, temperature, compressive stress, and magnetisation upon the electrical conductivity of certain varieties of magnetite. The varieties tested range from those having relatively high magnetic susceptibility to a variety having low susceptibility combined with high retentivity.

Specimens tested at constant temperature showed that electrical resistance fell as impressed voltage increased, the gradient increasing with voltage.

Papers read in title only:—

C. E. T. Mann. *The Determination of Coefficients of Diffusion in Gels by means of Chemical Analysis, and a Comparison of Results obtained from those yielded by the Indicator Method.* Communicated by W. B. Hardy, Sec. R.S.

A method for the determination of the coefficients of diffusion of a number of chlorides by means of chemical analysis was described. The method is equally applicable to sulphates and other substances.

Coefficients of diffusion of seven chlorides were recorded and compared with the values obtained by the indicator method.

An attempt has been made to account for the differences noted in the values obtained by the two methods.

A relationship, apparently linear, between diffusion and the degree of dissociation of the solute was noted.

C. E. P. Brooks. *The Difference-Periodogram—A Method for the Rapid Determination of Short Periodicities.* Communicated by Dr. G. C. Simpson, F.R.S.

J. Proudman and A. T. Doodson. *The Principal Constituent of the Tides of the North Sea.* Communicated by Prof. H. Lamb, F.R.S.

D. H. Bangham and F. P. Burt. *The Behaviour of Gases in Contact with Glass Surfaces.* Communicated by Prof. H. B. Dixon, F.R.S.

The rates at which different gases are taken up by a large surface of glass have been measured at different pressures and at 0° C. The data indicate that equilibrium was not achieved, even though in one case the experiment was extended for five weeks. Practically all the time-sorption data were fairly represented by the empirical equation $S^m = Kt$, where S is the sorption value at time t, and m and t are constants. While this relationship is to be regarded as the initial stage of the process, evidence was given that it is liable to persist for very long periods.

Since in experiments carried out at a number of approximately constant pressures, equilibrium conditions were not achieved, the theoretical sorption-pressure isotherms could not be tested directly. More static conditions were obtained, following long periods of sorption, the pressure being reduced by successive steps. Under these conditions the Freundlich isotherm was found to hold in all cases with a high degree of precision.

The experimental results showed that variations of sorption with pressure and with time are expressible by relations of the same functional form. With ammonia these variables are connected by a peculiarly simple relationship.

The quantities of different gases taken up under similar conditions run closely parallel with their solubilities in water, but

even when the surface is highly desiccated these quantities exceed those required to form molecular layers.

A MAGNETIC THEORY OF VALENCY.

At a meeting of the Faraday Society held in the rooms of the Chemical Society, on February 18, Principal A. P. Laurie put forward some suggestions for a magnetic theory of valency, based on the model of an atom which he has recently devised. The lecture was illustrated by lantern slides.

THE OPTICAL SOCIETY.

REPORT OF THE COUNCIL TO THE ANNUAL MEETING OF MEMBERS, FEBRUARY 14, 1924.

The Council of the Optical Society presents the following Report for the year ending December 31, 1923:—

Nine Ordinary Meetings of the Society took place during the year, which were held at the Imperial College of Science and Technology, by permission of the Governors and Professor Callendar, to whom the thanks and appreciation of the Society are due.

The meeting of February 8 was distinguished by the Presidential Address delivered by Sir Frank Dyson, M.A., D.Sc., LL.D., F.R.S., on "Large Telescopes," which was received by a considerable attendance of members with great interest.

At the meeting on November 27, Professor M. von Rohr delivered the Thomas Young Oration on the subject, "Contributions to the History of the Spectacle Trade from the Earliest Times to Thomas Young's Appearance." In honour of the occasion, Professor von Rohr presented to the Society copies of his translation into German of the two papers by Thomas Young on the Mechanism of the Eye, for which Professor von Rohr received the thanks of the Society.

On April 26, members paid a visit to the factory of the Hadley Company at Surbiton with much interest and appreciation.

By invitation from the Astronomer Royal a visit was paid to the Royal Observatory, Greenwich, on June 9, and the thanks of the Society are due to Sir Frank Dyson and his staff for their hospitality and interesting demonstrations.

In conjunction with the Physical Society of London, the Thirteenth Annual Exhibition of Electrical, Optical and other Physical Apparatus was held at the Imperial College of Science and Technology, on January 3 and 4, and, as in previous years, was largely attended.

During the year members were invited by the Board of the Institute of Physics to the series of lectures on "Physics in Industry," which have been introduced with such success, and the thanks of the Society are due to the Board for their courtesy.

The Illuminating Engineering Society invited representatives of the Optical Society to take part in a discussion on the "Projection of Light," which was held at the Royal Society of Arts on February 20. Instructor-Commander T. Y. Baker, Mr. J. Guild and Dr. L. C. Martin represented the Society on this occasion.

In the early part of the year the Society was invited by the Conjoint Board of Scientific Societies to be represented on the General Council of Honour of the International Air Congress, which was held in London during June and, on the invitation of the Council, Mr. A. C. W. Aldis represented the Society in this capacity.

Mr. R. S. Whipple has continued to represent the Society on the National Committee for Physics and on the Conjoint Board of Scientific Societies up to its dissolution in April, while Mr. J. Guild has continued to represent the Society on the Board of the Institute of Physics.

Of the special series of meetings originally initiated for the purpose of bringing into wider recognition the valuable and unique collections of optical apparatus at the South Kensington Museum, the fourth was held on January 25, when Mr. Wilfred E. L. Day gave a lecture on "The Birth of Cinematography and its Antecedents." The lecture was illustrated by a large number of "magic" lantern slides and apparatus of historic interest, together with a number of historical books, amongst which were several lent by Mr. T. Court. The fifth lecture of the series was delivered on March 22, by Dr. L. C. Martin, on "Surveying and Navigational Instruments from the Historical Standpoint." The sixth lecture was delivered on May 24, when Mr. David Baxandall discoursed on "Early Telescopes in the Science Museum from an Historical Standpoint." Both these lectures were illustrated by many historical instruments taken from the Museum. The thanks

of the Society are due to Colonel H. G. Lyons, F.R.S., Director of the Science Museum, for the loan of valuable instruments which illustrated these lectures.

It has been decided that in future Ordinary Meetings of the Society may be held occasionally at 5 p.m., instead of 7.30 p.m., when such meetings are devoted to papers of a purely scientific or mathematical nature not likely to be of direct interest to trade members.

LIBRARY.

The following books have been received during 1923:—

British Scientific Instrument Research Association. Fourth Annual Report for the year 1921-22.

Sprechsaal-Kalendar für die Keramischen Glas- und verwandten Industrien, 1923.

Generalised Linear Perspective, by J. W. GORDON.

Advanced Practical Physics for Students, by B. L. WORSNOP, B.Sc., and H. T. FLINT, M.Sc., PH.D.

Mirrors, Prisms and Lenses. A Text-book of Geometrical Optics, by JAMES P. C. SOUTHALL.

Photography as a Scientific Implement. (Applied Physics Series.)

Les Applications des Interférences Lumineuses, by CH. FABRY.

La Lumière Monochromatique, sa Production et son Emploi en Optique Pratique, by CH. FABRY.

Penrose's Annual: The Process Year Book, Vol. 26, Edited by WILLIAM GAMBLE, F.R.P.S., F.O.S.

No additions have been made to the journals now regularly received, the list of which is given in the Report of the Council for the year ending December 31, 1922.

Members possessing valuable optical works are invited to follow the example of others who have submitted lists of their private libraries for consultation in the library at 10, Clifford's Inn, Fleet Street, E.C.4, and haev expressed their willingness to loan out any work upon request by the Librarian (Mr. J. H. Sutcliffe). The Library will take full responsibility for any work while on loan.

MEMBERSHIP.

During the year the Fellowship was conferred upon six members. Sixteen new members were elected, of whom five are Corporate Members. Three names were removed from the list under Rule IX., 18 resignations were tendered, and two members died. There is, therefore, a decrease of seven in the membership of the Society, leaving the number of members on January 1, 1924, as follows:—

Honorary Fellows	10
Fellows	101
Fellows non-resident in British Isles	9
Members	148
Corporate Members	8
Members non-resident in British Isles	24
Corporate Member non-resident in British Isles	1
Student Members	2
TOTAL	303

TREASURER'S REPORT FOR THE YEAR 1923.

The receipts for the year are within £2 of those of last year, but as they include £42 on account of Life Compositions there is a falling off in the true income of about £40, almost entirely due to smaller receipts from sales of publications. This falling off is to some extent due to the fact that it was only possible to issue Nos. 4 and 5 of Volume XXIV. of the *Transactions* just before Christmas, so that there have been no sales of these numbers apart from subscribers to the volume.

The expenditure is about £174 less than last year, the principal reduction being one of £110 in the cost of printing and distributing the *Transactions*. The net result is a balance of income over expenditure of £177 10s. 4½d. The Society is thus in a healthy financial position.

The books and manuscripts of the Society are insured against fire with the Guardian Assurance Co., Ltd., for the sum of £300, but no credit has been taken for their value in the Balance Sheet, or for subscriptions in arrears.

E. O. HENRICI,
January 5, 1924. *Hon. Treasurer.*

THE SOCIETY OF PUBLIC ANALYSTS & OTHER ANALYTICAL CHEMISTS.

The Annual General Meeting of the Society was held at the Chemical Society's Rooms, Burlington House, on Wednesday, February 6, when the President, Mr. P. A. Ellis Richards, delivered his annual address.

The following were elected as Officers and Council for

President: G. Rudd Thompson; Past-Presidents (serving on the Council): Leonard Archbutt, A. Chaston Chapman, Bernard Dyer, Otto Hehner, P. A. Ellis Richards, Alfred Smetham, E. W. Voelcker, J. Augustus Voelcker; Vice-Presidents: S. F. Burford, F. H. Carr, A. More; Hon. Treasurer: Edward Hinks; Hon. Secretary: E. Richards Bolton; Assistant Hon. Sec.: R. G. Pelly; Other Members of Council: F. W. F. Arnaud, H. Ballantyne, E. T. Brewis, R. T. Colgate, R. L. Collett, J. C. Drummond, S. Elliott, E. M. Hawkins, H. F. E. Hulton, A. E. Parkes, A. R. Tankard, J. F. Tocher.

ORDINARY MEETING.

Held at the Chemical Society's Rooms, Burlington House, on Wednesday, Feb. 6. Mr. G. Rudd Thompson (President) in the chair.

Certificates were read for the first time in favour of:—

Messrs. Philip Walter Alloway; Lorentz Oliver Brekke, B.Sc. (Leeds), A.I.C.; Alex. Munro Cameron, B.Sc., F.I.C.; Thomas William Drinkwater, L.R.C.P., L.R.C.S. (Edin.), F.I.C.; John Ralph Furlong, Ph.D. (Wurzburg), A.I.C.; Ernest Griffiths-Jones, M.Sc. (Manch.), A.I.C.; Basil Gordon McLellan, F.I.C.; William Thomas Rigby, F.I.C.

Certificates were read for the second time in favour of:—

Messrs. Hugh Browning Brown, A.I.C.; Sidney Augustus de Lacy, A.I.C., A.M.I.-Chem.E.; Joseph Henry Lane, F.I.C., B.Sc. (Lond.); Leslie Herbert Lampitt, D.Sc. (Birm.), F.I.C.; Reginald Francis Moon, B.Sc. (Bristol); Maxmilian Nierenstein, D.Sc. (Geneva), Ph.D. (Berne); William Simpson Shaw, M.Sc., A.I.C.; Robert Norman Wright, A.R.C.S., B.Sc. (Lond.), A.I.C.; Misses Phyllis Honor Price, B.Sc. (Bristol); Mabel Suzanne Lavinia Snelus, A.I.C., M.P.S.

The following were elected members of the Society:—

Messrs. Thomas Francis Doyle, George Hogan, F.I.C., Frank Knowles, Archibald Knox, A.I.C., Charles Roger Middleton, B.Sc. (Lond.), A.R.C.S., D.I.C., A.I.C., Harold Richard Read, A.I.C., A.R.C.Sc. (Dublin).

The following papers were read:—

Osmium Tetroxide as a Reagent for the Estimation of Tannins and their Derivatives, by C. AINSWORTH MITCHELL, M.A., F.I.C.

Osmium tetroxide (the osmic acid of the microscopists) can be used as a sensitive reagent for tannins and their derivatives, being capable of detecting, *e.g.*, 1 part of gallic acid in 3,000,000. The coloration ranges from red-violet in dilute solutions to violet-black in concentrated solutions. Unlike the author's ferrous tartrate reagent, *osmium tetroxide gives similar colorations* with both the pyrogallol and catechol tannins. For quantitative work the ordinary 1 per cent. microscopic stain is diluted with 10 parts of water and a solution of 0.1 grm. of pure pyrogallol, catechol, or gallic acid is used as the standard. The colorations produced by catechol and pyrogallol are relatively proportional to their molecular weights, and the same relationship applies to the colorations given by protocatechuic acid and catechol, but gallic acid gives a relatively more intense coloration than pyrogallol. The method affords a convenient means of estimating the pyrogallol and catechol tannins together, in terms of catechol, pyrogallol, or gallic acid, and it has been applied to the analysis of various products, such as extracts of wood, commercial sawdust intended for curing fish, bacon, etc. It has also been found applicable to the colorimetric estimation of tannins in coffee, hops, etc.

Demonstration of Apparatus for Fat Extraction and Solvent Recovery, by S. A. DE LACY, A.I.C.

The apparatus consists of an extraction vessel with a three-holed stopper, one hole for the special key device, one for the attached condenser, and one for the tube to lead away the vapours of distilled solvent. The material to be extracted is suspended in a container supported in the extraction vessel, and the key device can be operated from the outside to close either the opening to the condenser or to the side tube, in turn. This device is essentially a thick, circular rod, attached to an oval-shaped platform, with a drip joint projecting from the lower surface.

THE ROYAL INSTITUTION.

The Friday evening discourse on Feb. 22 will be delivered by PROF. G. ELLIOT SMITH, F.R.C.P., M.R.I., on *The Human Brain*.

On Tuesday, Feb. 19, JOSEPH BARCROFT, F.R.S., gave his second lecture on *The Res-*

piratory Pigments in Animal Life and Their Significance.

On Thursday, Feb. 21, Sir William Bragg, D.Sc., F.R.S., gave his third lecture on *Crystalline Structure of Organic Substances.*

THE CHEMICAL SOCIETY.

Ordinary Scientific Meeting, Feb. 21.

The following papers were read:—

The Rotatory Dispersive Power of Organic Compounds. Part XI.—Octyl Alcohol and Octyl Oxalate, by T. M. Lowry and E. M. Richards.

Investigations on the dependence of Rotatory Power on Chemical Constitution. Part XXII.—Simple and Complex Rotatory Dispersion, by H. Hunter.

The Rotatory Dispersive Power of Organic Compounds. Part XII.—Borneol, Camphor and Camphorquinone. Asymmetric Atoms and Asymmetric Molecules, by T. M. Lowry and J. O. Cutter.

The Rotatory Dispersive Power of Organic Compounds. Part XIII.—Halogen-Derivatives of Camphor. Optical Superposition in the Camphor Series, by T. M. Lowry and J. O. Cutter.

THE MINERALOGICAL SOCIETY.

Tuesday, February 19.

Papers read:—

F. N. Ashcroft. *Mineral Localities in the Tavetschthal, Switzerland.* (Illustrated by lantern slides).

E. D. Mountain. *On Crystals of Calcite from Holywell, N. Wales.*

H. C. G. Vincent. *Chemical Analyses of Granite from Dufton, Westmorland, and of Mica from Burma.*

THE SOCIETY OF GLASS TECHNOLOGY.

A meeting of the Society was held in Sheffield on Wednesday, February 20.

The following firms exhibited pyrometers and demonstrated their use: The Bowen Instrument Co., Ltd.; The Cambridge and Paul Instrument Co., Ltd.; The Foster Instrument Company; The Optical Pyrometer Syndicate. Messrs. Booth and Miller also demonstrated their new temperature controller.

A general discussion on "The Use of Pyrometers in Glass Works" was introduced by the following papers:—

The Use of Pyrometers in Glass Works, by E. A. Coad-Pryor, B.A.

Continuous High Temperature Measurements in Glass Works, by W. M. Clark, Ph.B., of Cleveland, Ohio, U.S.A.

Recent Advances in the Design of Temperature Measuring Instruments, etc., by R. S. Whipple, F.Inst.P.

Practical Applications of Pyrometers to Glass Works, by C. E. Foster.

Reflections on Pyrometer Design, by W. Bowen.

THE CHEMICAL SOCIETY OF JAPAN.

Communication received:—

On Cucoline (Sinomenine) and Dehydrocucoline (Dehydrosinomenine), Alkaloids in Root of Sinomenum diversifolius (Cocculus diversiolius), Menisferaceæ; Part I., by Kakuji Goto.

NOTICES OF BOOKS.

Organic Synthesis, by Hans Thacker Clarke and Others. Pp. V. + 104. Vol. III. London: Chapman & Hall, Ltd., 11, Henrietta Street, Covent Garden, W.C.2. 1923. 7s. 6d. net.

The scheme outlined and standard set in the first volume of this series of Organic Syntheses has been adhered to and maintained in the current volume, which contains the modes of preparation of 28 compounds.

It is interesting to note that the number of contributors continues to augment, and the methods described have all been tested by other chemists, so that perfect reliance may be placed in the procedures outlined.

The preparations given have been selected over a wide range of organic chemistry, and include such diverse bodies as acetal, arsanilic acid, benzoic anhydride, catechol (two methods), various esters, hydroxylamine hydrochloride, mercury di-*p*-tolyl, *p*-nitro-benzoyl chloride, nitromethane, &c.

In each example there is described: 1, Procedure; 2, Notes; 3, Other Modes of Preparation. The index in this volume includes the matter contained in volumes I. and II. (for notices of which see *The Chemical News*, 1922, CXXIV., 174, and 1923, CXXVI., 127).

BLINDED SOLDIERS AS TELEPHONE OPERATORS.

It may not be generally known that one of the most successful occupations taught to the blinded soldiers at St. Dunstan's is telephone operating. A large number of these men have found employment with important business firms and organisations

In London and the provinces, and not a few employers state that their board has never been so well and efficiently managed as by their blinded soldier operator. This may be because the freedom from outward distraction—a natural accompaniment of blindness—enables the blind operator to concentrate on his work to a much higher degree than is possible in the case of a sighted operator, and thus he can maintain an excellent service.

St. Dunstan's has several fully-trained men ready for work. There may be some readers extending their premises, or faced with a necessary change in their present arrangements who might like to give a St. Dunstan's operator a trial. If so, the *authorities at St. Dunstan's Headquarters,* Inner Circle, Regent's Park, N.W.1, will gladly supply full particulars.

A point to bear in mind is that the employer's liability for his blinded soldier operator is no more than in the case of any ordinary employee. To his employer he is a perfectly normal member of the staff. His special needs as a blinded ex-Service man are the permanent and sole responsibility of St. Dunstan's After-Care Organisation.

New Patents.

'his list is specially compiled for *The Chemical News* by Messrs. Rayner & Co., Registered Patent Agents, of 5, Chancery Lane, London, from whom all information relating to Patents, Trade Marks, and Designs can be obtained gratuitously.

Abstract Published this Week.

08382—Emulsified sulphur terpene compounds.—Pratt, W. B., of 28, Pine Street, Wellesley Hills, Wellesley, Massachusetts, U.S.A.

Emulsions, making; impregnating-compositions.—Aqueous emulsions of sulphur-terpene compounds of the type described in Specification 69513 are prepared by adding water containing a saponifying agent to a mixture of the sulphur-terpene compound and a saponifiable agent; the sulphur-terpene compound may first be dissolved in a solvent such as benzene which is subsequently recovered by distillation. In an example, a mixture of 5 parts of oleic acid with 95 parts of a sulphur-terpene compound softened by heat is treated with 100 parts of water to which have been added 5 parts of ammonia and 1 part of oleic acid. Instead of oleic acid, an oil or a mixture of glycerides of the fatty acids may be used. The emulsifying agent may be subsequently removed. The products may be mixed with emulsions of other substances, and are stated to possess the same range of application as the unemulsified compounds. The treatment of fabrics is referred to.

Messrs. Rayner & Co. will obtain printed copies of the published specifications and abstract only, and forward on post free for the price of 1s. 6d. each.

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THE CHEMICAL NEWS,

VOL. CXXVIII. No. 3333.

BRITISH INDUSTRIES FAIR.

Promising Trade Prospects for 1924.

It is expected that 1924 will prove the most momentous and beneficial year for British trade since the war. In addition to the great exhibition at Wembley, the British Industries Fair at the White City is already assured of such support from overseas buyers as will probably establish a record.

In previous years the Fair has been held in February. This year, to meet the convenience of the many buyers who will be attending the opening weeks of the British Empire Exhibition, it has been decided to hold it in London, from April 28 to May 9, and at Castle Bromwich Aerodrome, Birmingham, from May 12 to 23. As a result it is expected that the number of buyers visiting the Fair will be far ahead of past years.

A quarter of a million invitations are annually issued by the organisers, the Department of Overseas Trade. Of these, a considerable quantity have already been issued to buyers in the more distant parts of the world. Of the acknowledgments so far received, over sixty per cent. state that the writers have definitely arranged to attend. A feature of these replies is the large proportion received from far away countries which have not been represented at previous Fairs. Iceland, Ecuador, Chili, Siam, Peru, China and Siberia will be among those represented, in addition to the better known commercial centres from which buyers attend the Fair each year as part of their regular business. Reports from Constantinople show that great interest in the Fair is being shown in Turkey, and reports from the remainder of the Near East are also encouraging.

Each of these buyers will receive a copy of the Fair catalogue immediately on his arrival. Classified by trades, this catalogue is so valuable as a permanent directory of British trades that applications for it are received throughout the year from buyers in all parts of the world.

Unlike the British Empire Exhibition, the British Industries Fair is not open to the public. From the point of view of the trade buyer this is of the greatest value in facilitating actual business. Another important factor for the doing of business in comfort and with despatch is that in both London and Birmingham all the exhibits are under one roof.

The national importance of increased export trade is now generally understood, and a great number of the exhibitors at the Fair have shown their appreciation of this fact by devoting the past year to a study of the needs of overseas markets. Prices, too, are lower as a whole than at any time since the war.

It has, during recent years, become a widely adopted rule for exhibitors to make the Fair their first opportunity of marketing their new lines for overseas consumption. There are indications that the coming Fair will be particularly valuable to buyers in this connection.

As in past years, there will be an information bureau, where trade inquiries of all kinds can be satisfied, and representatives of the Department of Overseas Trade in constant touch with every trade will be able to introduce buyers to exhibitors able to satisfy their requirements. A corps of interpreters will also be in attendance and prepared to meet every possible requirement.

Naturally the great mass of exhibitors at the Fair are manufacturers who have exhibited for years past, but space can usually be found for new firms by extending the area of the Fair, provided that applications are received in good time. Such applications should be made to the Secretary, British Industries Fair, 35, Old Queen Street, Westminster, S.W.1, from whom full information as to the most suitable way of organising contemplated exhibition displays can also be obtained.

ARRANGEMENT OF ELECTRONS IN THE ATOM.

Prof. Sir J. J. Thomson, who has contributed so much to science, gives expression to many new ideas in his book, "The Electron in Chemistry" (reviewed in *The Chemical News*, 1923, CXXVII., 383). We quote below one of particular interest at the present time.

"Confining ourselves, then, to the consideration of things whose existence has been demonstrated, we regard the atom as

made up of a massive positively electrified centre surrounded by electrons. The number of electrons increasing from one in the atom of hydrogen to a hundred or more in the heavier elements. The positive charge of the centre and the negative charges on the electrons will produce a field of electrical force which will be determinable when the position of the electrons can be specified. Thus the force exerted by the atom, and therefore its chemical properties, will depend upon the configuration of the electrons, and to determine this is one of the most important problems in the electron theory of chemistry. This problem is that of determining the way the electrons will arrange themselves under the action of their mutual repulsions and the forces exerted upon them by the positive charge. In the first place, we observe that if these forces were to vary strictly as the inverse square of the distance, we know by Earnshaw's theorem that no stable configuration in which the electrons are at rest or oscillating about positions of equilibrium is possible, the electrons must describe orbits, and further, they must describe different orbits; for such a system as that in Saturn's rings where several units follow each other round the same orbit, it is not possible when the units, as the electrons would do, repel each other instead of attracting one another like the constituents of Saturn's rings. When there are several electrons in the atom the orbits described by the electrons would be of great complexity, and the mental picture conveyed by this multitude of orbits would be too blurred and complicated to be of much assistance in helping us to get readily a clear idea of what is going on in chemical processes.

"I have therefore adopted the plan of supposing that the law of force between the positive part and the electrons is, at the distances with which we have to deal in the atom, not strictly that of the inverse square, but a more complex one which changes from attraction to repulsion as the distance between the positive charge and the electron diminishes. This hypothesis leads to a simple mental picture of the structure of the atom, and its consequences are in close agreement with the facts of chemistry. I suppose that the repulsive force between two *electrons* is always inversely proportional to the square of the distance. With regard to this point I may point out that we have no direct evidence as to what may be the law of force between electrical charges at distances comparable to 10^{-8} cm., which is a distance which we have reason to believe is comparable with that which separates the positive charge from the electron in the atom. The direct experimental verification of this law has been, of course, made at incomparably greater distances, while the direct experiments, such as those on the scattering of the alpha particles, only give information as to the law at distances very small compared with 10^{-8} cm.

"I shall assume that the law of force between a positive charge and an electron is expressed by the equation:

$$F = (Ee)/r^2[1-(c/r)],$$

where F is the attraction between the charge, E, e, the positive and negative charges on the core and the electrons, respectively, r the distance between them, and c is a constant varying from one kind of atom to another, it is the distance at which the force changes from attraction to repulsion and is of the order of 10^{-8} cm.

"We may remark, in passing, that the introduction of some new physical law, involving directly or indirectly a length of this order, is necessary for any theory of the structure of atoms. We could not form a theory at all if all we knew about the action of electric charges was that they repelled or attracted inversely as the square of the distance, for this would put at our disposal only two quantities, the mass of an electron and its charge, and so could not furnish the three units of space, mass and time required for any physical theory. The discovery of the induction of currents, or, what is equivalent, the magnetic effect due to electric charges, introduced another fundamental unit, the velocity of light; the unit of length to which this system leads is the radius of the electron, about 10^{-13} cm., a quantity of quite different order from 10^{-8} cm., which corresponds to atomic dimensions. The size of atoms being what it is, is a proof that there is some law of physics not recognised in the older science which is all-important in connection with the theory of the atom, and must form the basis of that theory. If the law of force is that just given, then a number of electrons can be in stable equilibrium around a positive charge without necessarily describing orbits around it."—Pages 3 to 5.

STUDIES IN THE REACTIONS OF THE AMINO GROUP IN 4' AMINO 1 PHENYL 5 METHYLBENZOTHIAZOLE.

PART VI.—DIAZONIUM COMPOUNDS OF DEHYDROTHIOPARATOLUIDINE.

By R. F. HUNTER, F.C.S.

(*Continued from Page* 104.)

Dehydrothioparatoluidine, on dissolving in hydrochloric acid, or in the form of a suspension in the latter, is diazotized to a mixture of syn and anti forms of the diazonium chloride (1), by means of amyl, ethyl, sodium nitrite, under suitable conditions. The syn and anti forms of (1) were isolated by Morgan (*J.C.S.*, 1922). It was decided to prepare from the diazonium salt, therefore, firstly, a typical azodye, the one formed by coupling with resorcinol was chosen (2); secondly, to repeat the work on the phenolic derivative, 4' hydroxy 1 phenyl 5 methylbenzothiazole (3); and lastly, to prepare the diazoamino derivative of dehydrothiotoluidine.

$$CH_3C_6H_3 <^{S}_{N}> C\ C_6H_4N : N\ Cl.$$

(1)

$$CH_3C_6H_3 <^{S}_{N}> C\ C_6H_4N_2C_6H_3(OH)_2$$

(2)

$$CH_3C_6H_3 <^{S}_{N}> C\ C_6H_4OH.$$

(3)

This paper describes the preparation of these on a laboratory scale. The thiazole ring does not function as an odorophore in these compounds, and as a consequence they are odourless. This is not surprising in view of the fact that dehydrothiotoluidine itself, the parent substance, is likewise odourless in the pure condition.

EXPERIMENTAL.

Dehydrothiotoluidine (see past papers and the *J.S.C.I.*, 1923):

1 Phenyl 5 methylbenzothiazole 4' azo m dihydroxy benzene.—4 gms. of dehydrothiotoluidine are made into a fine suspension with 30 ccs. of concentrated hydrochloric acid in a 250 cc. beaker. The same volume of ice water is then added, and the beaker placed in and kept in a freezing mixture until its temperature is 0° C.

The theoretical sodium nitrite in 30 ccs. of ice water, previously cooled in a freezing mixture, is then slowly run in from a tap funnel without constant stirring. A minute or two after the addition the solution clears to a dark brown liquid. There should be no smell of nitrous acid after the addition. The theoretical resorcinol dissolved in 30 ccs. of 2N caustic soda is now added from a tap funnel, after having been cooled in a freezing mixture. The addition of the first drop of coupler produces an immediate bright red precipitate. Approximately uniform stirring should be maintained during the addition. When the addition of coupler is complete, the beaker is allowed to stand for half an hour. Salt is then stirred in (50 gms.), and the beaker left for another hour. The red precipitate is then filtered and washed free from salts with hot water, finally with a small quantity of dilute alcohol, and the product dried on the steam and weighed. The yield is nearly theoretical for normal coupling.

4' Hydroxy 1 *phenyl* 5 *methylbenzothiazole*:

The preparation of this on a small scale has already been described by the author (*loc. cit.*). In this case 5 gms. of dehydrothiotoluidine were worked up after the method described, the diazo solution being boiled for four hours. The product, after purification by means of alkali and hydrochloric acid, was dried, and a portion recrystallised from hot alcohol in the form of pale yellow crystals. The crystals were nearly white. The yield was about 50 per cent.

Diazoamino compound of dehydrothiotoluidine.

The preparation was as for the azo colour, only the diazotization was carried out in sulphuric acid solution. The proportions used were theoretical. The product was obtained as a brown solid in good yield.

The Imperial College of Science and Technology.
South Kensington, S.W.7.

January, 1924.

CRITICAL STUDIES ON METHODS OF ANALYSIS.

VII.—Cobalt.

By Leon A. Congdon and Ta Hsien Chen.

[*Contribution from the Department of Chemistry, Syracuse University.*]

Introduction.

About twenty-three methods and modifications for the quantitative estimation of cobalt were abstracted from the chemical literature. Of these methods, nine were gravimetric, seven volumetric, four electrolytic, and three were for a colorimetric process. The six methods selected for examination were all gravimetric ones, and were as follows:—(1) Dufty's method, first as the sulphide and then as the pyrophosphate; (2) Schoeller and Powell's pyrophosphate method; (3) Slawik's alpha-nitroso-beta-naphthol method in alcoholic solution; (4) Eder's *alpha-nitroso-beta-naphthol* method in acetic acid solution; (5) A. Carnot's ammonium molybdate method; and (6) Landrum's fusion with potassium bisulphate, sulphide - oxide method.

Principle of the Methods.

Dufty's gravimetric method for cobalt depends upon the precipitation of the cobalt as sulphide and then the conversion into ammonium cobalt phosphate, and finally to the pyrophosphate by ignition, and weighed as such.

Schoeller and Powell's method depends upon the direct precipitation into the ammonium cobalt phosphate, and finally into the pyrophosphate by ignition, and weighed as such.

Slawik's method is a modification of Burgess's method. He precipitates the cobalt into an insoluble complex organic salt by means of alpha-nitroso-beta-naphthol in alcoholic solution, instead of acetic acid solution used by Burgess's original method. The insoluble complex is ignited to Co_3O_4, in which form it is weighed.

Eder's method is very similar to Burgess's original method of using nitroso-beta-naphthol for the precipitant in 50 per cent. acetic acid solution until precipitation is complete. Eder does not use oxygen to help oxidize the cobalt salt in a platinum Rose crucible, as Burgess recommends.

A. Carnot's method has for its principle the estimation and separation of cobalt by conversion of the cobalt salt into roseo- or purpureo-cobalt-chloride by action of H_2O_2, NH_4Cl, and NH_4OH, and then converted into $Co_2O_3.10NH_3.7MoO_3.H_2O$ by ammonium molybdate, and the latter changed into $2CoO.7MoO_3$ after ignition, in which form the cobalt is weighed.

R. W. Landrum's method is based on the fusion of insoluble cobalt material, such as ores and enamels with a mixture of potassium bisulphate, the cobalt and other sulphide metals are separated by H_2S, the cobalt is separated from the other sulphide metals by paying strict attention to the hydrogen ion concentration until cobalt is found in solution and again precipitated as the sulphide, changed to the oxide, and weighed as Co_3O_4.

Experimental.

A sample labelled, $Co(NO_3)_2.6H_2O$, containing 0.021 per cent. Ni, 0.002 per cent. Fe, a very slight trace of sulphate, and no copper, was dried by filter paper so that the crystals rattled. This sample was then found to be $Co(NO_3)_2.5H_2O$. For analysis, 16.7845 grams were dissolved in water and made up to 500 cc. with water in a volumetric flask. For each determination, 10 cc. of this solution was used, giving 0.3357 gram for the sample.

(1) Dufty, Lawrence, *Jour. Iron Steel Ind.*, 1914, XC., 52-65.

(2) Schoeller, W. R., and Powell, A. R., *Analyst*, 1917, XLII., 189-199; *Ibid.*, 1919, XLIV., 275-280; Moorse, Thomas, *Chem. News*, 1892, LXV., 74.

(3) Slawik, G. T., *Chem. Zeit.*, 1914, XXXVIII., 514-515.

(4) Eder, Alois, *Chem. Zeit.*, 1922, XLVI., 430; Burgess, *Zeit. Angew. Chem.*, 1896, 596.

(5) Carnot, A., *Compt. Rend.*, 1917, CLXIV., 897-903; *Jour. Soc. Chem. Ind.*, 1917, 908.

(6) Landrum, R. W., *Trans. Am. Chem. Soc.*, 1910, XII.

The following table gives the results of the six gravimetric methods tried:—

Method used	Amt. of Sample grams	Theor. Amt. Co P.c.	Amt. Co found p.c.	Avge. amt. Co found p.c.	Diff. from theor. p.c.
Dufty's gravimetric (sulphide-pyrophosphate)	0.3357	21.57	21.54 21.51	21.53	-0.04
Dufty's (modified by the authors)			21.61 21.58	21.59	+0.02
Schoeller & Powell's gravimetric (pyrophosphate)	0.3357	21.57	21.32 21.41	21.37	+0.20
Schoeller & Powell's (modified by the authors)			21.41 21.51	21.49	-0.08
Slawik's gravimetric (nitroso-beta-naphthol-oxide) (-alcohol-)	0.3357	21.57	21.63 21.24 21.58 21.59	21.51	-0.06
Eder's gravimetric nitroso-beta-naphthol- (acetic acid)- oxide	0.3357	21.57	21.54 21.59	21.56	-0.01
Carnot's gravimetric (ammonium-molybdate)	0.3357	21.57	21.74 22.86 22.25 21.24 21.32 22.15	21.92	+0.34
Landrum's gravimetric (sulphide-oxide)	0.3357	21.57	21.52 21.19 21.50 21.52	21.52	-0.05

Several difficulties were observed in some of these methods. In the Dufty's process and also the Schoeller and Powell method, it was found that there is not a complete precipitation of the cobalt as double ammonium phosphate, and if accurate results are to be obtained the cobalt in the filtrate must be recovered by precipitation as sulphide and ignited as Co_3O_4. If this process or modification is observed in these two methods, very accurate results are obtained, and the authors suggest this as a *modification of these two methods if* very accurate work is required. Such a modified procedure would give in the case of Dufty's method an average of 21.59 per cent. of cobalt, with only a theoretical difference of +0.02 per cent. instead of -0.04 per cent., as by Dufty's unmodified method. In the case of Schoeller and Powell's process, our modified process would give an average of 21.49 per cent. of cobalt, with only a theoretical difference of -0.08 per cent. instead of -0.20 per cent., as by Schoeller and Powell's unmodified method.

The difficulties in A. Carnot's ammonium molybdate method are, first of all, the precipitate is soluble in both ammonia and acid solution, hence the neutralisation need utmost care.

This neutralisation process is difficult, as the solution itself is reddish pink in colour, and no indicator other than litmus paper

can successfully be used for the neutral point, and the latter is not sensitive enough to serve the purpose for very accurate work. In this connection the precipitate is slightly more soluble in ammonia than in dilute acid. The second difficulty found was that on heating the precipitate it decreased in weight at first, but increased after a few weighings—making it difficult to obtain constant weights, and, as the table of results shows, gave variable results.

In Slawik's process and in Eder's method modified from Burgess's original method by precipitation with nitroso-beta-naphthol, it is found that better results are obtained in 50 per cent. acetic acid solution than in alcoholic solution of the insoluble organic complex. The reagent will also precipitate copper and iron from solution, and also silver, bismuth, chromium and tin not so completely. These methods can be used in the presence of aluminium, antimony, arsenic, cadmium, calcium, glucium, lead, magnesium, manganese and nickel.

SUMMARY AND CONCLUSIONS.

1.—Six gravimetric methods for cobalt were critically studied and examined, namely, Dufty's, Schoeller and Powell's, Slawik's, Eder's, Carnot's and Landrnm's.

2.—Dufty's and Schoeller and Powell's methods were modified by the authors, so as to give very accurate results, by taking the filtrate from the ammonium cobalt phosphate precipitate and recovery of the cobalt as the sulphide and conversion of the sulphide into Co_3O_4, in which form the lost cobalt is weighed. The amount of cobalt so recovered is added to that of the original found by the pyrophosphate method.

3.—It was found that the formula for cobaltous nitrate is not $Co(NO_3)_2.6H_2O$, but $Co(NO_3)_2.5H_2O$ if the nitrate is carefully dried on filter paper so that the crystals are free from the supernatant water, as all inorganic preparations should be.

4.—The accuracy of the methods examined can be classed as follows:—Eder's nitroso-beta-naphthol acetic acid-oxide method; Dufty's (modified by the authors) sulphide-pyrophosphate process; Dufty's straight sulphide pyrophosphate process; Landrum's sulphide-oxide process; Slawik's nitroso-beta-naphthol alcohol-oxide method; Schoeller and Powell's (modified by the authors) pyrophosphate process; Schoeller and Powell's straight pyrophosphate method; and A. Carnot's ammonium molybdate process.

GENERAL NOTES.

THE MINERAL INDUSTRY OF CANADA.

The prospects for the mineral industry of Canada are bright. Operations in most of the mining districts are now conducted on a pre-war basis, and for the first half of the year 1923 the total production of metallic and non-metallic minerals, exclusive of structural materials and clay products, was 45 per cent. greater than for the first half of the year 1922.

The gold and coal mines have been scenes of activity during 1923, and the output has been very considerable.

The nickel industry has resumed its pre-war activity. The benefit to be derived from thorough and careful research work is well illustrated in the matter of nickel research. Investigations were undertaken for the purpose of extending the application of this metal in the industries of peace. The properties of the pure metal nickel and of non-ferrous nickel alloys were carefully studied and the result was that new demands were created. Surplus stocks have been wiped out, and extensive mining operations have been resumed.

The production of copper in 1923 exceeded the total for 1922. There are three great copper-producing centres; Anyox and Britannia Beach, both on the Pacific coast of British Columbia, and Sudbury, Ontario. The company operating at Anyox has been active in mining operations, in reaching out after new properties, and in development work. Several million tons of ore at the Hidden Creek mine are said to have been blocked out ready for mining. This company also acquired control of the large copper deposit on Copper Mountain in Southern British Columbia, and, encouraged by the better outlook in the copper situation during the first half of the year, commenced preparations for mining.

The leading silver producing province is Ontario, British Columbia being second and Yukon third. In Yukon territory argentiferous galena carrying about 200 ounces of silver per ton has been produced from the Mayo area during the last three years. In British Columbia the gold-silver deposits of Salmon river, and the lead-zinc ores of the

southern part of the province are the principal sources of silver.

The discontinuance late in May of the purchase of silver by the United States Government, under the Pittman Act, has turned the thoughts of the silver producers of the United States to the possibilities of extending the silver market by increasing the application of this metal in the arts and industries, and suggestions have been made that research work to this end be conducted under Government supervision.

The production of lead and zinc was never greater than at present. British Columbia is the premier province, and the greater part of her lead and zinc is obtained from the Sullivan mine at Kimberley. A considerable quantity of lead and zinc comes from the mine at Galetta, Ontario, and of argentiferous lead from the Mayo area, Yukon territory.

Drilling for oil carried on during the summer of 1923 was not altogether unsuccessful. No new flows were struck on Mackenzie river. Traces of oil were found by drilling in southern Alberta, where it was hoped to find a northward extension of the Montana field, but no commercial field has yet been opened.

Success has attended the efforts in eastern central Alberta. The monoclinal or terrace-like structure indicated by the Geological Survey a few years ago as existing in this area has attracted the oil prospector. Traces of oil and heavy flows of gas have been struck from time to time. From the Viking field a gas pipe line to Edmonton was completed during the year. In November, 1923, a flow of heavy oil, said to amount to 100 barrels per day, was encountered near Wainwright. The discovery will no doubt lead to an increase in drilling activities in this area.

The striking of a strong flow of oil in the Trenton formation in Romney township, Ontario, will in all probability lead to further prospecting. The Trenton formation has proved the source of traces of oil on Manitoulin island and of a small productive field in the township of Dover West, but owing to its depth it has not been thoroughly prospected.

Asbestos.

The renewal of building operations and other commercial activities in 1922 revived the asbestos market, but did not lead to a return of war prices.

COTTON, A WORLD ASSET, ENDANGERED BY THE BOLL WEEVIL.

(*Reprinted from "Manufacturers' Record."*)

A vital contribution to the economic stability of the American people and of all other nations of the world was the announcement by the American Cotton Association of a boll weevil control campaign which it is hoped to finance by means of a public fund of two and one-half million dollars.

Compared with the hundreds of millions of dollars of annual loss caused by the boll weevil, the sum named for this campaign is infinitesimal, but even this small sum wisely expended can produce more constructive results at this stage than all the vast sums spent for this purpose heretofore.

The most important feature of the programme outlined by the American Cotton Association is the opportunity thus afforded to co-ordinate the efforts of each existing agency and to stimulate and develop all possible new means of combating this pest.

The very lack of co-ordination is the fundamental cause of the failure of all efforts in the past. Millions of dollars have been expended and the efforts of hundreds of scientific and industrial leaders have been concentrated upon this problem, in increasing ratio as the revages of the weevil has increased.

But this ravenous insect horde from the tropics, purely parasitic in its instincts and acclimated year by year to the greater vigours of our more northern zones, has marched on as irresistibly and as dramatically as any invasion, human or pestilential, that is recorded in the history of civilisation. It must be admitted that the principal reason for the demonstrated failure to stem the tide is not far to seek. There has been no one single agency for the direction of the expenditure of either the money or the energy available, nor has there been any one central clearing house or recognised headquarters where all methods might be studied, compared and classified without the handicap of official or personal jealousy and the restrictions of governmental red tape or the profit and loss sheet of industrial enterprise.

All credit should and will be given for the unselfish effort and frequently brilliant scientific achievement of federal, state and

county officials, institutional experts and industrial investigators, but the brutal fact must be faced. The absolute lack of unification of effort rather than the mere limitations of actual authority, has prevented the utilisation of the beneficial results of more than a very small fraction of these many agencies.

A glaring example of this phase of the existing situation is the crisis just realised regarding arsenic supplies. It is unprofitable as well as unfair to blame either the different departments at Washington or the various industrial groups involved, because at this late hour they claim that the one means of successful control is apparently drawing on an empty well. But any effort in the past to correlate facts readily ascertainable would have indicated the necessity of either placing less devendence on the use of arsenic or else of developing new supplies to be available when the remedy was proven. Indicating the same weakness in the past, but from a different angle, is the lack of unity among entomologists regarding methods of control. Only by vigorous differences of opinion can constructive progress be made, but discussion, investigation and experiment are in vain when all of the results are not properly tabulated and compared. The necessary division of the work among Federal, State, institutional and private organisations makes official or compulsory unity impossible, and at a recent conerence in Washington where entomologists gathered from all over the South, the differences of opinion were so pronounced that the real subject of the conference was not discussed at the only public meeting held, for fear of increasing the existing anxiety regarding the boll weevil situation.

Within a lifetime the American nation has been involved in war on three different occasions, and each time war found us unprepared. And each time the President has functioned for the duration of the emergency as an autocratic dictator rather than as a constitutional executive. The present emergency surely justifies a dictatorship which would weld every possible agency into an organised army to combat the boll weevil, but legislative action which could so result is not possible at the present time. And a dictator of less prestige than the President himself could not compel by force the co-operation needed.

The American Cotton Association offers the only alternative, a single leadership, which without compulsion other than that of the urgency of the need, will permit the co-ordination of effort necessary to prevent catastrophe.

The campaign will not supplant any existing medium, but it will supplement the effort of each and every agency which is not active, and will also stimulate every other resource the nation has available.

It is not a threat of war which confronts us; the insect enemy has successfully accomplished its invasion, and already is strongly entrenched in the vitals—at the source—of our greatest single economic asset. And the American people must respond to this call to the colours sounded by the American Cotton Association, or we must face the destruction of the cotton industry, with the incalculable loss thus entailed.

PROCEEDINGS AND NOTICES OF SOCIETIES.

THE ROYAL SOCIETY.

THURSDAY, FEBRUARY 21.

Papers read:—

C. TATE REGAN, F.R.S. *The Morphology of a Rare Oceanic Fish, Stylophorus chordatus, Shaw; based on Specimens collected in the Atlantic by the "Dana" Expeditions,* 1920-1922.

F. P. SLATER. *A Sensitive Method for observing Changes of Electrical Conductivity in Single Hygroscopic Fibres.* Communicated by Dr. W. L. Balls, F.R.S.

T. S. P. STRANGEWAYS. *Observations on the Formation of Bi-Nuclear Cells.* Communicated by W. B. Hardy, Sec. R.S.

J. A. CROWTHER. *Some Considerations relative to the Action of X-Rays on Tissue Cells.* Communicated by W. B. Hardy, Sec. R.S.

An analysis of the observations of Strangeways and Oakley on the immediate effects of soft X-rays on tissue cells suggests that the effect follows a probability law. It is suggested that this probability is the probability that ionisation will be produced in some particular body within the cell by the action of the rays. The size which this body must have to account for

the observations is deduced, and is found to be approximately 1/2500 mm. This appears to be of the order of magnitude of the centrosome in the cells employed in the experiments.

THURSDAY, FEBRUARY 28.

Papers read:—

PROF. O. W. RICHARDSON, F.R.S. *Thermodynamics of Electron Emission.*

PROF. W. A. BONE, F.R.S., D. M. HEWITT and D. T. A. TOWNEND. *Gaseous Combustion at High Pressures. Part IV.*

J. E. P. WAGSTAFF. *An Electrical Method of Determining the Velocity of Detonation of Explosives.* Communicated by Sir Robert Robertson, F.R.S.

Paper read in title only:—

PROF. W. L. BRAGG, F.R.S. *The Refractive Indices of Calcite and Aragonite.*

THE ROYAL INSTITUTION OF GREAT BRITAIN.

The Friday evening discourse on February 29 will be delivered by F. E. SMITH, C.B.E., F.R.S., on *Modern Navigational Devices.*

On Tuesday, February 26, JOSEPH BARCROFT, F.R.S., gave a lecture on *The Respiratory Pigments in Animal Life and their Significance.*

On Thursday, February 28, SIR WILLIAM BRAGG, D.Sc., F.R.S., gave his fourth lecture on *Crystalline Structure of Organic Substances.*

PHYSICAL SOCIETY OF LONDON.

A meeting was held on February 22, when the following papers were read:—

A Generalisation of Whitehead's Theory of Relativity, by G. TEMPLE, B.Sc.

The Structure of the Atomic Nucleus and the Mechanism of its Disintegration, by DR. HANS PETTERSSON.

The Effect of a Magnetic Field on the Surface Tension of a Liquid of High Permeability, by MISS WINIFRED ROTTON, B.Sc., and MR. R. STANLEY TROOP, B.Sc.

Proceedings at the Annual General Meeting, held on February 8, Alexander Russell, M.A., D.Sc., in the chair:—

The following Officers and Members of Council were elected for 1924:

President: F. E. Smith, C.B.E., F.R.S.

Elected Vice-Presidents: E. H. Rayner, M.A., Sc.D.; J. H. Vincent, D.Sc., M.A.; T. Smith, B.A.; C. R. Darling, F.I.C.

Hon. Secretaries: D. Owen, B.A., D.Sc.; Prof. A. O. Rankine, O.B.E., D.Sc.

Hon. Foreign Secretary: Sir Arthur Schuster, Ph.D., Sc.D., F.R.S.

Hon. Treasurer: W. R. Cooper, M.A., B.Sc.

Hon. Librarian: J. H. Brinkworth, M.Sc., A.R.C.Sc.

Other Members of Council: R. W. Paul; Prof. C. L. Fortescue, O.B.E.; W. S. Tucker, D.Sc.; Prof. S. W. J. Smith, M.A., D.Sc., F.R.S.; J. S. G. Thomas, D.Sc.; J. Guild, A.R.C.Sc., D.I.C.; F. L. Hopwood, D.Sc.; E. A. Owen, B.A., D.Sc.; J. Robinson, M.Sc., Ph.D.; G. B. Bryan, D.Sc.

Professor Max Planck was elected an Honorary Fellow of the Society.

On behalf of the Council, Dr. Alexander Russell awarded the first Duddell Memorial Medal "for the advancement of knowledge by the invention or design of scientific instruments or by the discovery of materials used in their construction" to Prof. H. L. Callendar, C.B.E., M.A., LL.D., F.R.S.

The President said that the award was made in respect of Prof. Callendar's work on the Electrical Resistance Thermometer, the Electrical Continuous Flow Calorimeter and other instruments; on the Steam Equation and problems connected with petrol engines; and on many other branches of the science of Heat.

At the Ordinary Meeting following the Annual General Meeting, F. E. Smith, C.B.E., F.R.S., in the chair, a paper on *Æolian Tones* was read by E. G. RICHARDSON, M.Sc. The paper was illustrated by demonstrations, and followed by a discussion.

The Effect of Torsion on the Thermal and Electrical Conductivities of Metals, by J.

E. Calthrop, B.A., B.Sc.

A method which has been described previously and used for the determination of the changes in the thermal conductivities of metal wires, is used for brass, iron, zinc, nickel and tin.

As in the earlier experiments, the small decreases obtained on twisting are proportional to the square of the twist, as is approximately the case for the electrical conductivities.

Iron has been most closely studied. It appears to require several days to return to its original value of the thermal conductivity after the twist has been removed, and if the twist is kept constant there is a slight return towards the initial value.

A discussion followed.

A Demonstration of a *Microscope for Observation of Interference Fringes* was given by C. W. Hawksley.

THE INSTITUTE OF METALS.

The following communications are expected to be submitted at the Annual Meeting, on March 12 and 13:—

The Relation between the Tensile Strength and the Electrical Resistivity of Commercially Pure Copper, by W. E. Alkins, M.Sc.

The Brittle Ranges in Brass as shown by the Izod Impact Test, by D. Bunting, M.Sc.

The Cadmium-Lead-Zinc System, by Maurice Cook, M.Sc., Ph.D.

The Relative Corrosion of Zinc and Lead in Solutions of Inorganic Salts, by J. Newton Friend, D.Sc., Ph.D., F.I.C., and J. S. Tidmus, B.Sc.

Determination of the Thermal Coefficients of Expansion of Some Commercial Metals and Alloys (Note), by J. Newton Friend, D.Sc., Ph.D., F.I.C., and R. H. Vallance, M.Sc.

Copper-Zinc Alloys which Expand on Solidification, by K. Iokibe, M.Sc.

The Equilibrium Diagram of the Copper-Tin System, by M. Isihara.

The Constitution of the Alloys of Copper and Cadmium, by C. H. M. Jenkins, B.Sc., A.R.S.M., and D. Hanson, D.Sc.

X-Ray Studies on the Copper-Aluminium Alloys, by E. R. Jette, G. Phragmen, and A. F. Westgren, Ph.D.

The Tensile Properties of Aluminium at High Temperatures, by Thomas Martin, M.Sc., D.I.C.

The Investigation of a Fatigue Failure of Brass Tubes in a Feed Water Heater—with a Consideration of the Nature of Fatigue, by W. E. W. Millington, M.Inst.C.E., M.I.Mech.E., and Prof. F. C. Thompson, D.Met., B.Sc.

The Effect of Casting Temperature on the Physical Properties of a Sand-Cast Zinc-Bronze (Note), by Francis W. Rowe, B.Sc.

The Aluminium-Copper Alloys. Alloys of Intermediate Composition, by David Stockdale, B.A.

Note on the Effect of Cold-Drawing and Annealing on Some Electro-Chemical Properties of a Low-Tin Bronze, by Stuart H. J. Wilson, B.Sc. (N.Z.), M.Sc. (Vic.).

THE ROYAL SOCIETY OF ARTS.

On February 20, a lecture, entitled, *New Uses for Rubber*, was given by Percival James Burgess, M.A., F.C.S., Chairman of the Rubber Growers' Association. Sir Stanley Bois, President, Ceylon Association in London, presided.

On Monday, February 25, the first Cantor Lecture, entitled *A Study of the Destructive Distillation of Coal*, was delivered by Edward Victor Evans, O.B.E., F.I.C., Chief Chemist and Products Manager of the South Metropolitan Gas Company, London.

On Wednesday, February 27, at the Ordinary Meeting, a lecture entitled *The Use of Psychological Tests in the Selection of a Vocation*, was delivered by Charles S. Myers, C.B.E., M.D., Sc.D., F.R.S., Director, National Institute of Industrial Psychology. Sir Robert Blair, M.A., LL.D., Education Officer, London County Council, presided.

THE INSTITUTION OF ELECTRICAL ENGINEERS.

An Ordinary Meeting was held on Thursday, February 28. A paper, entitled, *The Design of Apprartus for the Protection of Alternating-Current Circuits*, was read by A. S. FitzGerald, Associate Member.

A Wireless Section meeting will be held on Wednesday, March 5, when a paper on

the *Development of the Bellini-Tosi System of Direction-Finding in the British Mercantile Marine* will be given by COMMANDER J. A. SLEE, O.B.E., R.N. (RET.).

The Design of Apparatus for the Protection of Alternating-Current Circuits, by A. S. FITZGERALD.

The paper dealt with differential protective systems, particularly those suitable for use where there is a neutral earthing resistance.

The operating conditions, and their influence on methods of design and construction, were discussed, and improved means of practically applying the various protective circuits were described.

The superiority of biased systems, in principle, was accepted as having been established, but the objections to a more complicated relay were recognised. The author advocated the use of simple relays only, in order to restrict to a minimum the employment of moving parts associated with small amounts of power.

The necessary functions peculiar to biased and certain other protective systems have led to the use of balanced beam, dynamometer, and other special forms of relay. The paper described how these features might be achieved with a simple relay and a static device called a "biasing transformer."

Current transformers and simple types of relay were briefly dealt with, and a further static device called a "phantom auxiliary switch" was described.

The application of the foregoing apparatus to actual protective circuits was described in the second portion of the paper, and attention was drawn to the advantages of dealing with earth faults and line faults independently.

THE FARADAY SOCIETY.

Papers read at the meeting on February 18:—

Suggestions for a Magnetic Theory of Valency, by PRINCIPAL A. P. LAURIE.

The Electronic Theory of Valency. Part IV.—The Origin of Acidity, by PROF. T. MARTIN LOWRY, C.B.E., M.A., D.Sc., F.R.S.

The increasing acidity of the hydrides from CH_4 to FH or from SiH_4 to ClH is attributed to a progressive diminution in the size of the orbits of the electrons by which the protons are linked to the central nucleus.

It is suggested that acylous atoms, such as chlorine, tend to diminish the size of the orbits of electrons which they share with another atom, and that this effect can be transmitted to other orbits of the same quantum-number in the latter atom. In this way the transmission of acidity through a chain of atoms can be interpreted by means of a dynamic, instead of a static, model. Conversely, basylous groups must expand the orbits of electrons which they share with other atoms.

From this point of view an unsubstituted hydrocarbon chain should act as a neutral radical in carboxylic acids, since orbits shared by two carbon atoms will be of normal dimensions. Hydrogen directly attached to an atom of sulphur, phosphorus, etc., is more acylous than an alkyl radical because it allows for a greater contraction of the orbits; but even a proton is less acylous than the "lone pairs" of electrons in acids such as FH and ClH, since contraction is probably at a maximum in orbits which are entirely unshared.

On Certain Physical Differences between Sols and Gels of Agar, by E. HATSCHEK and R. H. HUMPHRY.

Agar sols and gels containing 3 per cent. and more of agar show marked optical differences, inasmuch as the sols are clear in transmitted and reflected light, while the gels, though clear in transmitted light, show marked opalescence in reflected light. Owing to the lateral scattering of light, the gels also appear darker in transmitted light than the corresponding sols. The opalescence does not decrease when the gels are kept for several days at a temperature of 62° C., that is, about midway between the setting and melting point.

The conductivity of agar gels containing electrolyte is greater, for both direct and alternating current, than that of the corresponding sols, the difference increasing with increasing concentration of agar.

The conductivity of agar sols and gels containing electrolyte is greater for alternating current than for direct current, the difference being slightly greater than that between the alternating and direct current conductivities of aqueous electrolyte solution of the same concentration without agar.

The Influence of Anions in the Coagulation of a Negative Colloidal Sol, by D. C. HENRY and V. A. MORRIS.

The coagulating power of an electrolyte for a lyophobe sol is largely determined by the nature of the ion of opposite sign to the colloidal particle, but is also influenced by the ion of the same sign, which exerts a stabilising action. Experiments have been carried out on the coagulating powers for a (negative) gold sol of a series of salts of the same cation (sodium), with the object of determining the relative stabilising powers *of the different anions. For each salt the* curve was traced connecting electrolyte concentration with the time required to reach a definite arbitrary stage of coagulation, estimated by a colorimetric method. *If the logarithms of the electrolyte concen*trations and the corresponding coagulation times are plotted, the curves obtained are either linear or of small curvature. The results indicate the following sequence of stabilising power of various anions when associated with sodium ion in the coagulation of a gold sol: oxalate $>HPO_4''>CO_3''>OH'$; Citrate $>HCO_3'>Br', I'$. Acetate and valerate are greater than butyrate, $CNS'>SO_4''>Cl'$, and benzoate.

The Diffusion Potentials and Ionic Mobilities of Benzoates and Salicylates, and their Modification by a Membrane of Parchment Paper, by Edmund Brydges Rudhall Prideaux and William Ernest Crooks.

It is well known that diffusion potentials are modified, and generally increased by the interposition of animal, vegetable and artificial membranes. In this work membrane potentials were treated as modified diffusion potentials, and measurements with potassium benzoate and salicylate indicated that the parchment had a specific effect on the transport number.

The conductivities and viscosities of the benzoates and salicylates were first determined, and then the diffusion potentials without a membrane. From this the transport numbers of the anions for the various salts were determined. A membrane of four thicknesses of parchment paper was then set horizontally in vertical tubes, and the transport numbers were re-determined, and from these results a new transport number of *the anion could be obtained*, which should give the relative mobilities of the ions in the membrane. The transport number of the anions was found to decrease in every case, and the authors consider this to be chiefly, if not entirely, due to a decrease in its mobility. It is suggested that this may be due to the larger diameter of the anions, or to a preferential adsorption of the anion on the parchment, although this material was chosen partly on account of its freedom from specific adsorption or chemical effects. Whatever may be the mechanism, the authors try to express the fact by means of a diminution of U_a in the *same ratio r.*

For sodium benzoate they find r - 0.725; for potassium benzoate, r - 0.745; and for potassium salicylate, r - 0.66. Hence, on this hypothesis, the parchment reduces the *mobility of the benzoic ion in the ratio* 0.735, and that of the salicylic ion in the ratio 0.66.

THE GEOLOGICAL SOCIETY.

February 6. Prof. A. C. Seward, Sc.D., F.R.S., President, in the Chair.

The following communication was read and discussed:—

The Upper Towy Drainage-System, by Prof. Owen Thomas Jones, M.A., D.Sc., F.G.S.

A meeting of the Society was also held on February 27, when the following communication was read:—

Age and Origin of the Lough Neagh Clays, by W. B. Wright, B.A., F.G.S.

The Annual General Meeting of the Society was held on February 15.

ROYAL AGRICULTURAL SOCIETY OF ENGLAND.

The proceedings at the Monthly Council, on Wednesday, February 6, when Mr. Ernest Mathews, C.V.O. (President), was in the chair, included the presentation of *numerous reports, including the Chemical* Report:

Mr. J. L. Luddington reported his election as Chairman for the year. Dr. Voelcker had reported on the progress of the work of the Departmental Committee on the Fertilisers and Feeding Stuffs Act, and also as to the action being taken by the Ministry of Agriculture regarding the tables of unexhausted manure values now in use.

THE CHEMICAL SOCIETY.

Papers read at the Ordinary Meeting on February 21:—

Investigations on the dependence of Rotatory Power on Chemical Constitution. Part XXII.—Simple and Complex Rotatory Dispersion, by HAROLD HUNTER.

An analysis of the four possible cases of the Drude rotatory dispersion equation with one or two terms shows the classification of rotatory dispersion into "simple" and "complex," corresponding respectively to a one term and a two term Drude equation, is impracticable. It was shown that the method of plotting the reciprocal of the rotatory power against the square of the wave length does not distinguish between simple and complex rotatory dispersion, but that it serves to differentiate normal from potentially anomalous dispersion. A return to this older system of classification is therefore inevitable.

Current ideas on the chemical significance of rotatory dispersion must be modified. There is no evidence that complexity of dispersion is symptomatic of chemical heterogeneity.

The Rotatory Dispersive Power of Organic Compounds. Part XI.—Octylalcohol and Octyl Oxalate, by T. M. LOWRY and E. M. RICHARDS.

It was shown that the rotatory dispersion of octyl alcohol can be expressed completely by one term of Drude's equation.

The rotatory dispersion of octyl oxalate, like that of sodium tartrate, approximates closely to the inverse square law of Biot, but a two-term equation is required to express it accurately.

The Rotatory Dispersive Power of Organic Compounds. Part XII.—Borneol, Camphor and Camphorquinone. Asymmetric Atoms and Asymmetric Molecules, by J. O. CUTTER and T. M. LOWRY.

The rotatory power of a strong solution of camphor in benzene has been measured for a series of 47 wave-lengths in the visible and ultra-violet regions. Shorter series of measurements have been made of a more dilute solution in benzene, and of solutions in cyclohexane and in acetone. Solutions in benzene of borneol and of camphorquinone have also been examined.

The rotatory dispersion of camphor and its derivatives is complicated (i) by the presence of selective as well as of general absorption, (ii) by the presence of two dissimilar asymmetric carbon atoms in camphor and of 2, 3 or 4 in its derivatives, (iii) by the tendency of camphor to form molecular compounds with the solvent.

The dispersion is shown to be *complex*, but not *anomalous*.

Strong support is given to the view that, in studying the rotatory power and rotatory dispersion of complex compounds containing asymmetric atoms, it is not sufficient to consider the dissymmetry of the molecule as a whole, since each asymmetric atom may contribute a separate share to the rotatory power of the compound, and a separate term or terms to the equations of rotatory dispersion.

The Rotatory Dispersive Power of Organic Compounds. Part XIII.—Halogen-Derivatives of Camphor. Optical Superposition in the Camphor Series, by J. O. CUTTER and H. BURGESS.

Measurements have been made of the rotatory dispersion of α and α^1 chlorocamphor, of α, α^1 and β bromocamphor, and of five isomeric dibromocamphors.

In nine cases the curves are *complex but normal*, *i.e.*, the rotation increases progressively as the wave-length diminishes, giving rise to quasihyperbolic dispersion curves, which do not exhibit any obvious anomalies; the dispersion is, however, not *simple*, since it cannot be represented by a single term of Drude's equation.

The dispersion can usually be represented by two terms of the Drude equation; but in one or two cases imaginary values are obtained for the constants, showing that the dispersions are of still greater complexity.

In the one case of α^1-bromocamphor, the negative term predominates over the positive term, and the complex dispersion becomes *anomalous*. The inflexion at 5455 A.U., maximum at 4710 A.U., and reversal of sign at 3890 A.U., have all been observed experimentally.

EXHIBITION OF WHITTINGTON GLASS.

An exhibition of old Whittington glass, kindly lent from his collection by Mr. T. Metcalf, of Chesterfield, has been arranged in the Department of Glass Technology of the University of Sheffield, commencing

Monday, February 18, and extending to Saturday, March 15.

The Whittington Glass Works (near Chesterfield) were in operation from about 1704 to the early part of the nineteenth century, its best work, of which various samples are shown, being done between 1750-1800.

THE ORIGIN OF THE SOLAR SYSTEM.

On the evening of February 15, at the Royal Institution, Albemarle Street, Dr. J. H. Jeans addressed a distinguished and enthusiastic audience on the problem of the evolution of the solar system. Dr. Jeans' work in this fascinating field is well known, and it was with great interest that we listened to his lucid exposition of this subject.

Dr. Jeans paved the way by first explaining some of the astronomical magnitudes. Of striking significance was the statement that the solar system was isolated from all other heavenly bodies, the nearest star being 25 million million miles away. This was illustrated by considering the whole solar system reduced to the size of a threepenny piece, then on this reduced scale the nearest star would be somewhere in Piccadilly. We are thus assured of the safety of the solar system from outside interference.

Of interest in this connection was the total number of stars in the heavens. Considering the eye as the smallest telescope, it could see only a very small fraction of the total stars in a given area of the night sky, but passing step by step to larger instruments until the largest telescope was reached, the number grew progressively, but not without a mathematical limit being indicated. By this growth, therefore, a limiting number was determined, and from mathematical calculations it was deduced that the number of stars was of the order of 15 hundred million. Yet with all these stars, and the various phenomena as revealed by the largest telescope, there appeared to be no duplication of the solar system.

There are several striking phenomena observed in the heavens, as for example the ring nebula with a star at its centre, but this was quite a rarity and presumably had no importance in the scheme of planetary evolution.

On the other hand, there are numerous spiral nebulæ. Some of these are of enormous size, and these are swirling masses of gaseous matter so rarified that ordinary gas effects involving molecular bombardment did not apply, but the law of gravitation was in evidence. In the arms of these huge spiral swirls were seen bright spots or stars, indicating condensations of the gaseous matter, and here, Dr. Jeans said, stars were being born.

Recent observations had shown that the matter of these huge spiral arms was moving outwards along them, for photographs had been compared after an elapse of some years and this displacement noted.

Here we have a clue to one of the great processes of nature, for some of the nebulæ of this type are seen on edge, and are of the shape of a double convex lens. This shape and the thin edge indicates rotation. The peripheral part of one of these lenticular masses was dark, indicating that no radiation was being emitted. These various nebulæ were shown on the screen, and dark streaks over the bright parts were pointed out by the lecturer.

It was evident that when the condensations took place great heat was present, as even in the bright parts of the nebulæ still brighter condensations appeared. These condensations presumably represent star formations, for as the mass of the star contracts its temperature increases, all in accordance with the laws of such actions. It is not supposed that the attenuated gaseous parts of the nebulæ represent high temperature, yet the stars that are born by condensations of this matter showed a state in incandescence.

In order to indicate how this process had worked in evolving the solar system, it was assumed that at an early epoch the sun was a nebulous mass much larger than at present. At some period in his history a star had brushed near enough to the sun to attract therefrom a filament of gaseous matter, which in turn underwent condensations similar to that observed in the nebulæ, and finally reached a comparatively cold state as we know the planets at present.

It can be shown that this nebulous stream is not stable, and that it would have broken up into isolated condensing bodies, which ultimately become the planets as we observe them. It should be noted that all these bodies are in rotation, and the matter which formed the planets must rotate quicker, from dynamical considerations as the mass contracts.

Dr. Jeans explained that by applying known laws to such bodies, they would, under the conditions assumed to have prevailed in the early history of the solar system, form just such mass magnitudes as the planets possess. The largest planet, Jupiter, being towards the middle of the stream or filament, would have the largest mass.

NOTICES OF BOOKS.

What Industry owes to Chemical Science, by R. B. PILCHER, O.B.E., and F. BUTLER-JONES, B.A. (CANTAB.), A.I.C. Pp. XV. + 158. 2nd Edition. 1923. London: Messrs. Constable & Co., Ltd., 10-12 Orange Street, W.C.2. 6s. net.

It is a pleasure for chemists to note that this volume, which presents to the general public, in a readable manner, the industrial advances achieved through recent chemical research, has reached a second edition. There is still reason for regret that industrialists and persons holding official positions do not yet realise the importance of the applications of scientific knowledge. The thanks of chemists are therefore due to the authors of this volume for bringing forward evidence of the part played by chemists in the advancement of metallurgy, and in the manufacture of oils, fats and waxes, leather, rubber, pottery, photography, etc.

The scope of the book, which covers such a wide field, has not been to treat of the various industries exhaustively, but the information contained is accurate and is lucidly presented.

The first edition appeared during the war; minor additions have been made, but the character of the book remains the same. and includes an introduction by Sir George Beilby. J.G.F.D.

The first number of *Milchwirtschaftliche Forschungen*, a journal devoted to the study of dairy science, has just been published by Julius Springer, Berlin.

The editor is Dr. W. Grimmer, Professor at Konigsberg University, and he is assisted by an able staff of contributors. This first number contains three interesting original researches and three papers of a more general character. Book reviews and abstracts of articles in various sections of agricultural science are also included.

The price is given as $1.40.

BOOKS RECEIVED.

X-Rays and Crystal Structure, by SIR W. H. BRAGG, K.B.E., M.A., D.Sc., F.R.S., and W. L. BRAGG, F.R.S. Pp. VIII + 322. Fourth Edition, 1924. Messrs. G. Bell & Sons, Ltd., York House, Portugal Street, W.C.2. 21s. net.

Chemical Synoms and Trade Names—A Dictionary and Commercial Handbook, by WILLIAM GARDNER, Works Chemist. Pp. IV. + 271. 1924. Messrs. Crosby, Lockwood & Son, Stationers' Hall Court, Ludgate Hill, E.C.4. 25s. net.

The Vegetable Proteins, by THOMAS B. OSBORNE, PH.D., Sc.D. Pp. XIII. + 154. Second Edition, 1924. Messrs. Longmans, Green & Co., 39, Paternoster Row, E.C.4. 9s. net.

Organic Synthesis, by HANS THACKER CLARKE and Others. Pp. 104. Vol. III., 1924. Messrs. Chapman & Hall, Ltd., 11, Henrietta Street, Covent Garden, W.C.2. 7s. 6d. net.

Differential Equations in Applied Chemistry, by FRANK LAUREN HITCHCOCK, PH.D., and CLARK SHOVE ROBINSON, S.M. Pp. VI. + 110. 1923. Messrs. Chapman & Hall, Ltd., 11, Henrietta Street, Covent Garden, W.C.2. 7s. 6d. net.

Monograph on Corrosion Tests and Materials of Construction for Chemical Engineering Apparatus, by W. S. CALCOTT, J. C. WHETZEL and H. F. WHITTAKER. Pp. VI. + 182. 1923. D. Van Nostrand Company, 8, Warren Street, New York, U.S.A. $3.00 net.

The Chemist's Year Book, by F. W. ATACK, M.SC.TECH., D.Sc. (MAN.). Pp. 1147. 1924. Messrs. Sherratt & Hughes, 34, Cross Street, Manchester. 21s.

The Fundamental Ideas of Chemistry, by DR. ALFRED BENRATH, translated by JETHRO BITHELL, M.A. Pp. 80. 1924. Messrs. G. Harrap & Co., Ltd., 39-41, Parker Street, Kingsway, W.C.2. 2s. net.

The Publicity Club of London has issued a booklet entitled *The Business Value of Publicity Clubs*.

New Patents.

This list is specially compiled for *The Chemical News* by Messrs. Rayner & Co., Registered Patent Agents, of 5, Chancery Lane, London, from whom all information relating to Patents, Trade Marks, and Designs can be obtained gratuitously.

Latest Patent Applications.

2376—Chemical & Metallurgical Corporation, Ltd.—Treatment of ores, etc., containing zinc. Jan. 29.

2472—Chemical & Metallurgical Corporation, Ltd.—Treatment of lead chloride, etc. Jan. 30.

2713—Coke, B. E.—Manufacture of phthalimide. Feb. 2.

2379—*Soc. of Chemical Industry in Basle.*—Manufacture of a thionaphthisatin and its intermediate products. Jan. 29.

3034—*Durkoppwerke Akt-Ges.* — *Iron separation* and desulphurising in cupola furnaces. Feb. 5.

3230—Soc. Chimique des Usines du Rhone.—Manufacture of calcium arsenate. Feb. 7.

3112—Soc. de Stearinerie et Savonnerie de Lyon.—Manufucture of cellulose esters. Feb. 6.

Specifications Published this Week.

209480—Weizman, C., and Blumenfeld, J.—Titanium compounds.

193625—Urfer, C.—Process for the manufacture of pulverulent catalysts for the synthesis of ammonia.

210011—Ashcroft, E. A.—Treatment of lead-zinc sulphide ores, mattes and the like.

210102—Scott, J. P.—Manufacture of hydrogen and oxygen.

210108—Dreyfus, H.—Manufacture of artificial horsehair and like products from cellulose derivatives.

210131—Chemical Research Syndicate, Ltd.—Process of producing hydrocarbons of relatively low boiling point.

210363—Vogel, Dr. H.—Process for the manufacture of colloidal sulphur.

Abstract Published this Week.

208578—Alkali carbonates; sulphur dioxide.—Plauson, H., of 26, Jarrestrasse, Hamburg, *Germany.*

Alkali carbonates are obtained by treating an alkali compound such as sodium sulphate, or an insoluble silicate such as feldspar, with gases containing carbon monoxide with or without steam or inert gas at 400-900° C. and under reduced pressure. Accelerators, such as ammonia, amines, or nitrogen oxides, may be added to the gases in small quantities. The reaction may be effected in a rotary furnace, the solid material entering at the end at which the gases leave. When treating sodium sulphate, the sulphur dioxide evolved should be withdrawn rapidly by suction or by continuous or intermittent admission of jets of steam or inert gas. The sulphur dioxide may be oxidised to trioxide and used to convert alkali chloride into sulphate. When feldspar is treated, the alkali carbonate is extracted from the treated material by lixiviation. When water-gas is employed as the source of carbon monoxide, it may be enriched in carbon monoxide by adding a limited quantity of air to burn the hydrogen only. The gases need not be free from carbon dioxide. The Provisional Specification states that the reaction may be effected under pressure.

Messrs. Rayner & Co. will obtain printed copies of the published specifications and abstract only, and forward on post free for the price of 1s. 6d. each.

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THE CHEMICAL NEWS,

VOL. CXXVIII. No. 3334.

THE STRUCTURE OF PHOSPHORUS.

By HAWKSWORTH COLLINS.

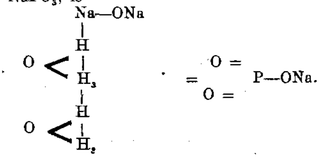
The atomic weight of phosphorus can be split up, in the manner demonstrated in *The Chemical News* (this Vol., pp. 81-84, Feb. 8), into five parts, from each of which emanates one valence:—

$$31 = 23 + (1 + 3) + (1 + 3).$$

No other number between 24 and 34 inclusive can be split up in this manner into five parts.

P is a non-metallic element owing to the presence of the two helium-portions, from each of which emanates a pair of electro-positive forces, whilst its single electro-negative valence emanates from the metallic portion of mass 23; *e.g.*, the molecule, 15° C:

$NaPO_3$, is



The fact that the element can also have three electro-negative and only two electro-positive valences, as in the molecule, Na_3PO_4, does not affect the truth of the preceding fact.

The above structure for an atom of phosphorus will now be proved to be true by means of facts concerning relative volume and heat of formation.

Table I. gives the relative volumes of P at 15° C., and also the volumes of the five portions of P. Table II. compares relative volumes of Al, Si, S and P. Table III. gives examples of molecules in which P may have either of the volumes, 14.56 or 16.87. Table IV. gives examples of relative volumes which confirm Tables I., II., and III.

TABLE I.

The relative volumes of Phosphorus at

P	=	Na	——	H	——	H_3	——	H	—— H_3
14.56	=	9.54	+	0.97	+	1.54	+	0.97	+ 1.54
10.51	=	9.54	+	0.97	+	0	+	0	+ 0
16.87	=	11.85	+	0.97	+	1.54	+	0.97	+ 1.54

TABLE II.

Relative volumes of Al, Si, P and S compared at 15° C:

Al	=	Na——H——H_3
12.05	=	9.54+0.97+1.54
Si	=	Na——H——H_3——H
13.02	=	9.54+0.97+1.54+0.97
P	=	Na——H——H_3——H——H_3
14.56	=	9.54+0.97+1.54+0.97+1.54
S	=	Na——H——H_3——H——H_3——H
15.53	=	9.54+0.97+1.54+0.97+1.54+0.97

TABLE III.

Molecules in which P has either of the volumes 14.56 or 16.87:

			Theor. S.G. at 15° C.	Obs. S.G.
(26)	P_2O_3	2(16.87) + 3(7.53)	1.953	1.936, 25° Chemiker Kalender, *i.e.*, 1.953, 15°
(27)	P_2O_3	2(14.56) + 3(7.53)	2.18	2.135 Thorpe
(28)	$POBrCl_2$	16.87 + 7.53 + 27 + 2(23.01)	2.03	2.049, 0°/4 Van Nostrand (*i.e.*, 2.03, 15°)
(29)	$POBrCl_2$	14.56 + 7.53 + 27 + 2(23.01)	2.08	2.059, 0° Menschutkin; 2.12, 0° Thorpe
(30)	$Na_3PO_4 + 12H_2O$	3(11.85) + 16.87 + 3(2.51) + 4.45 + 12(14.09)	1.832	1.822 Playfair and Joule
(31)	$Na_3PO_4 + 12H_2O$	3(11.85) + 14.56 + 3(2.51) + 4.45 + 12(14.09)	1.65	1.6645 Dufet

TABLE IV.

Relative volumes which confirm the three preceding tables:

		Theor. S.G. at 15° C.	Obs. S.G.
(32)	$POCl_3$ 14.56 + 7.53 + 3(23.01)	1.685	1.686, 15° Buff
(33)	P_2O_4 2(14.56 + 7.53 + 2.51)	2.56	2.537, 22°.6/4 Van Nostrand (*i.e.*, 2.55, 15°)
(34)	WP_2 21.59 + 2(10.51)	5.8	5.8 Van Nostrand
(35)	W_2S_2 2(21.59) + 15.53 + 10.51	6.241	6.26, 20° Schafarik
(36)	Fe_3P 3(7.05) + 10.51	6.286	6.28 Hvoslef
(37)	FeS 7.05 + 10.51	5.01	5.035 Playfair and Joule 4.75 Smith
(38)	PS_6 16.87 + 6(15.53)	2.026	2.02 Duppe
(39)	PCl_3 16.87 + 3(23.01)	1.601	1.601, 15° Regnault
(40)	$Al_2Ba(SiO_4)_2$ 2(12.05) + 24.58 + 2(13.02 + 7.53) + 6(2.51)	3.57	3.573 Levy
(41)	$Al_5BaNa_3Si_{11}O_{32}$ 5(12.05) + 24.58 + 3(11.85) + 11(13.02 + 7.53) + 21(2.51)	2.906	2.906 Levy
(42)	$BaH_4P_2O_4 + H_2O$ 23.98 + 4(5.76) + 2(14.56) + 4(2.51) + 14.03	2.834	2.839 Schroder
(43)	KH_2PO_4 18.05 + 2(5.76) + 14.56 + 4.45 + 3(2.51)	2.424	2.403 Buignet
(44)	KH_2PO_4 18.05 + 2(5.76) + 14.56 + 7.53 + 3(2.51)	2.298	2.298 Schiff
(45)	$Tl_4P_2O_7$ 4(22.29) + 2(14.56 + 7.53) + 5(2.51)	6.786	6.786 Lamy
(46)	Tl_2S 2(22.29) + 10.51	8.00	8.00 Lamy
(47)	H_3PO_3 5.76 + 2(9.95) + 16.87 + 3(2.51)	1.638	1.651, 21°.2 Thomsen
(48)	H_3PO_4 5.76 + 2(9.95) + 14.56 + 4.45 + 3(2.51)	1.88	1.88 Schiff
(49)	$NaPO_3$ 11.85 + 16.87 + 7.53 + 2(2.51)	2.47	2.476 Mohr
(50)	P_3N_5 3(10.51) + 5(6.62)	2.52	2.51, 18° Van Nostrand

Other examples are given in *The Chemical News*, Aug. 18 and 25, 1922, and Mar. 29, 1923. The relative volume 14.03 (= 2 × 5.76 + 2.51) for a crystallised molecule of H_2O will very frequently occur in these papers. Its heat of formation from liquid water is 3205 calories.

Five different cases of the heat of formation of phosphorus are given in the following paragraphs (*a*), (*b*), (*c*), (*d*) and (*e*):—

(*a*) The heat of formation of an atom of phosphorus in some compounds is −8593, which splits up by the law (*The Chemical News*, Aug. 18 and 25, 1922), into 120 × (−2.31) × 31.

The specific gravity of red P is 2.129.
2.106 Schrotter.
2.14 Brodie.

31, divided by 2.129, gives 14.56 for the relative volume; so that the H.F. shows that the original volume 14.56 increases by 2.31, becoming 16.87.

E.g., the heat of formation of solid Na_3PO_4 is 3(32706) − 8593 + 3(96155) + 71515 = 449505 452400 (observed).

This corresponds exactly with No. 30 in Table III. Whenever this is said to be the case, the implication is:

(i) That the theoretical S.G. and H.F. are each within 1 per cent. of the experimental values;

(ii) that each atom in the molecule conforms exactly with the law of H.F..

(iii) that the relative volume of each atom in the molecule has a definite structural meaning, which is demonstrated partly by the law of relative volume (*The Chemical News*, Feb. 15, 1924), and partly by other facts.

(*b*) If an experiment were made, starting with red P, whose atomic volume is 14.56, and if a compound were produced with P having the same volume, the H.F. of that P would be zero, because the volume does not alter.

E.g., the heat of formation of aq.

$BaH_4P_2O_4$ *is* 81926 + 4(-15300) + 0 + 4(96155) = 405346 403000 (observed).
This corresponds with No. 42 in Table IV.

(c) The H.F. of P can also be +8593, which equals 120 × 2.31 × 31. S.G. of yellow P is 1.838. 1.82 - 1.84, 10° Schrotter.

31, divided by 1.838, gives 16.87 for the relative volume. And the H.F. shows that the original volume, 16.87, decreases by 2.31, becoming 14.56.

E.g., the H.F. of aq. KH_2PO_4 is 37274 + 2(-15300) + 8593 + 71515 + 3(96155) = 375247, 374400 (obs.) This corresponds with No. 43 in Table IV.

(*d*) If an experiment were made starting with yellow P, whose atomic volume is 16.87, and if a compound were produced with P having the same volume, the H.F. of that P would be zero, because the volume does not change.

E.g., the heat of formation of H_3PO_3 is - 15300 + 2(-24350) + 0 + 3(96155) = 224465, 224630 liq. Thomsen. This corresponds with No. 47 in Table IV.

(*e*) If an experiment were made starting with yellow P of volume 16.87, and if a compound were produced with P having the volume 10.51, its H.F. would be 23659 = 120 × 6.36 × 31, because the volume decreases by 6.36.

E.g., the heat of formation of P_3N_5 is 3(23659) + 5(-30500) = -81523, -81500 (observed). This corresponds with No. 50 in Table IV.

Any fact which is not supported by sufficient evidence in this paper will be confirmed later.

The above experimental facts concerning phosphorus afford another exact confirmation of the law of H.F.

It has been found necessary to restate this law as follows:—

The heat of formation of an element is proportional to the product of the atomic weight and the change of volume; there being two distinct series, the sodium elements and the sub-sodium elements.

The former elements are those of atomic weight greater than 22, and the latter those of atomic weight less than 22

THE BROMINATION OF SUBSTANCES CONTAINING A THIAZOLE RING.

PART I.—THE BROMINATION OF DERIVATIVES OF 4′ AMINO 1 PHENYL 5 METHYLBENZOTHIAZOLE.

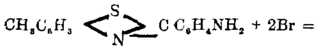
BY R. F. HUNTER, F.C.S.

During his work on 4′ amino 1 phenyl 5 methylbenzothiazole (1), Gatterman observed that when this thiazole was dissolved in glacial acetic acid and brominated, a dibromo addition product was formed according to the reaction:

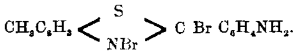
$C_{14}H_{12}N_2S + 2Br = C_{14}H_{12}N_2SBr_2$.

Anschultz and Schultz, during their research on the preparation of the homologues of dehydrotbiotoluidine, observed the formation of similar brom addition products in the cases of the dehydroxylidines from amino p xylol and from amino pΩ xylol.

The only part of the molecule of (I) which is unsaturated is clearly the thiazole ring which contains a double bond between the nitrogen and carbon atoms in the heterocyclic ring of the fused homocyclic-heterocyclic ring system or benzothiazole system. Since the reaction has been shown to be clearly one of addition and not as one might suppose at first one of substitution, we should expect the addition to take place at the double bond in the thiazole nucleus, that is to say, to take place according to the scheme:



(1)



(2)

and that as a consequence that the brom addition product would have the structure (2).

If this is correct, then, clearly this reaction should he general, and apply to all benzothiazoles of this type, in fact to all compounds containing a thiazole ring, though the reaction will be modified by the presence of certain substituents on the thiazole ring which may diminish the degree of *unsaturation of the double bond.*

By normal acetylation, dehydrothiotolui-

dine yields the acetyl derivative (3), and, clearly, this should brominate according to

$$CH_3C_6H_3 < \overset{S}{\underset{N}{}} > C\;C_6H_4\;NHCO\;CH_3 + 2Br =$$

(3)

$$CH_3C_6H_3 < \overset{S}{\underset{NBr}{}} > CBr\;C_6H_4\;NH\;COCH_3,$$

(4)

to give (4).

Green prepared the acetyl derivative (3) by the usual type of acetylation with acetic anhydride in glacial acetic acid solution. He dissolved a small quantity of this in glacial acetic acid, and added bromine to the solution, when a yellow precipitate formed. This, he found, was a very unstable compound, evolving bromine when heated or on boiling with water.

It was decided to repeat Green's work and isolate the dibromo derivative of acetyldehydrothiotoluidine with the view to analysis.

4′ Acetylamino 1 phenyl 5 methylbenzothiazole was prepared as described in the experimental part of this paper. The acetyl compound was then dissolved in glacial acetic acid and brominated as described. The yellow addition product was isolated, washed with water and dilute alcohol, and finally recrystallised from alcohol, from which it was obtained in the form of yellow crystals. The observations on the relative low stability of the compound were confirmed it being found that heat split off bromine, and that boiling water had the same effect. The crystals were placed aside and left for two or three days in a bottle. At the end of this time the crystals had disappeared, and a nearly colourless liquid remained in the bottle. The dibromo compound of dehydrothiotoluidine itself was then prepared, as described hereunder. This compound, on the other hand, is quite stable even to boiling water, and to heat above 100° C., although at high temperatures decomposition sets in with the evolution of bromine fumes.

By the condensation of dehydrothiotoluidine with benzaldehyde in the presence of ethyl alcohol, a nearly theoretical yield of benzal dehydrothiotoluidine (5) is obtained according to the equation:

$$CH_3C_6H_3 < \overset{S}{\underset{N}{}} > C\;C_6H_4NH_2 + C_6H_5CHO$$

$$CH_3C_6H_3 < \overset{S}{\underset{N}{}} > C\;C_6H_4\;NCH\;C_6H_5 +$$

(5)

Benzaldehydrothiotoluidine should clearly brominate to the compound (6) according to:

$$CH_3C_6H_3 < \overset{S}{\underset{N}{}} > C\;C_6H_4\;NHCH\;C_6H_5 +$$

(5)

$$CH_3C_6H_3 < \overset{S}{\underset{NBr}{}} > CBr\;C_6H_4\;NHCH\;C$$

(6)

in glacial acetic acid solution. The first bromination was performed in acetic acid solution. This method, however, has disadvantages. In the subsequent experiments, therefore, the benzaldehydrothiotoluidine was dissolved in warm ethyl alcohol and brominated by adding bromine drop by drop from a burette charged with the latter, which affords a smoother bromination.

Experimental.

Dehydrothiotoluidine was prepared and worked up by the method given by the author (*Trans. Soc. Chem. Ind.*).

4′ Acetylamino 1 phenyl 5 methylbenzothiazole:

This was prepared by the following method: 5 gms. of dehydrothiotoluidine from alcohol is dissolved in the minimum of acetic anhydride (20 ccs.). The solution is refluxed for ten minutes on a sand bath and under a water condenser. The brown liquid is then drowned in 350 ccs. of cold water, and the vessel containing the precipitate (which should be a clean white) left for an hour or more, to allow decomposition of the anhydride to take place. The precipitate is then filtered at the pump and washed with warm water and dilute alcohol. Yield: theoretical.

Bromination:

1 gm. of the acetyl compound prepared as

above is dissolved in 20 ccs. of glacial acetic acid. To the solution is then added 2 ccs. of bromine, drop by drop from a burette with steady stirring. A yellow brown precipitate settles out on the addition of the bromine. The beaker containing the precipitate is allowed to stand for 15 minutes, and the precipitate filtered on to a filter paper. The product is well washed with water and dilute alcohol, allowed to dry, and recrystallised from alcohol. After a few minutes' refluxing, the yellow crystals which separate on cooling are unstable and are decomposed by allowing to stand for some days at room temperature.

Benzaldehydrothiotoluidine:

5 gm. of dehydrothiotoluidine is dissolved in the minimum of hot alcohol, and the theoretical benzaldehyde for the normal condensation added. The solution is then refluxed for ten minutes on a water bath under a reflux water condenser. The solution is then poured into a beaker immersed in cold water, and the liquid allowed to cool, when fine yellow crystals separate out to a nearly theoretical yield. These are filtered and washed with alcohol.

Bromination:

As in the case of the acetyl compound, save that the bromination is carried out not in glacial acetic acid solution but in alcoholic solution, the product is a brown solid, which is freed from unchanged base by refluxing with hot ethyl alcohol, washing the residue, and allowing to stand on the steam.

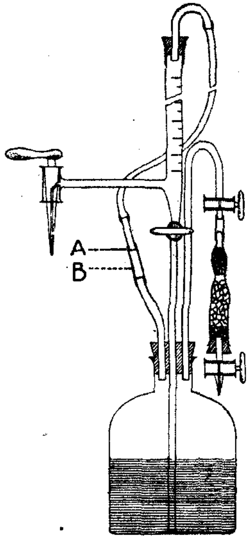
The Imperial College of Science and Technology,
South Kensington, S.W.7.

December, 1923.

AN AUTOMATIC BURETTE WITH AN IMPROVED GUARD SYSTEM.

By F. J. Considine.

The accompanying sketch shows a well-known type of automatic burette with an improved guard system. The thin rubber suction tube is furnished with a glass tip at A., which is detachable from the short rubber tube B., connected by glass tubing with the interior of the storage bottle. The stopper at the top of the burette is also conveniently held by a rubber sleeve.



To operate the system, the taps are appropriately adjusted and the rubber tube, B., is firmly compressed by the operator's finger and thumb, while the glass tip, A., is detached and mouth suction is applied, in order to fill the burette in the usual way. Before releasing the pressure upon B., the glass tip is replaced, thereby closing the system against the access of unpurified air.

For solutions not requiring scrubbed air, the scrubber and supporting tube may be omitted from the outfit, but in this case the tubes, A. and B., are left open to the air while the burette is in use. At other times it is connected up to maintain a closed system.

The tap connecting the burette to the storage bottle should be of high grade and of large dimensions. Charging is then almost an instantaneous and bubble-free operation.

It will be noted that the guarded solution comes into contact with nothing but glass

and purified air, and the facility for return to storage of unused portions of the solution ensures a marked saving of reagents.

This has been found a very compact, strong, and efficient assemblage.

GENERAL NOTES.

CANADIAN METALLURGICAL PROGRESS IN 1923.

Considerable progress has been made during the year in the erection of new plants, additions to existing plants, and the remodelling and opening of old ones to meet the conditions of advanced metallurgical practice. New industrial plants have been built for the iron and steel industry; new concentrators have been built or are in course of erection for the copper and lead-zinc industries; additions to existing plants have been made, or are in course of erection, for the nickel industry, and new milling plants have been put into operation, additions made, and old mills remodelled for the gold and silver industries.

The outstanding features of metal production in Canada for 1923 are increases in the production of iron and steel, copper, nickel, and cobalt, while the production of lead, zinc, silver, and gold will be practically the same as that of the preceding year. Although market conditions were favourable for an increased production of these latter metals, the production of lead and zinc was governed largely by the capacity of the concentrators and refineries to separate and produce these metals. The lower silver values in the British Columbia ores are the chief reason for no increased production of this metal, and the shortage of power during the first six months of the year was largely the cause of no increase in the gold production.

Iron and Steel.

Two companies made shipments of iron ore during the year. Small shipments were made from the agnetite deposits of Texada Island, B.C., for experimental purposes. Twenty-four thousand and sixty-two tons of beneficiated magnetite were shipped from stock by Moose Mountain, Ltd., from their plant at Sellwood, Ont., of which 16,468 tons went to the Hamilton blast furnace. This was largely for experimental purposes in connection with the smelting of beneficiated magnetites from Ontario ores.

The production of pig iron and steel will sho wa marked increase over that of the preceding year. Pig iron production, which was 383,057 tons for 1922, should exceed 800,000 tons or 1923, and the production of steel ingots and castings, which was 485,643 tons for 1922, should be in excess of 900,000 tons for 1923.

Copper.

The production of copper should be double that for 1922, as the first six months' production was larger. It will compare favourably with the years 1914, 1919 and 1920.

The copper smelter, refinery, and rod mill of the Consolidated Mining and Smelting Co. of Canada has been idle, due to the low price of copper, and consequently to their inability to obtain a continuous supply of ore and concentrates. Due to the high price of coke, this company is seriously considering electric smelting instead of the former blast furnace practice, and is conducting experimental work on British Columbia ores with this purpose in view.

Nickel and Cobalt.

The production of nickel will be far in excess of 1922, and slightly above pre-war production. The International Nickel Co. had four blast and one reverberatory furnace in operation for the greater part of the year at their smelting works, Copper Cliff, Ontario. The refinery at Port Colborne resumed operations during the year. The Mond Nickel Co. had two furnaces continuously in blast at their smelting works, Coniston. This company's matte is shipped to Wales for refining. The British America Nickel Corporation was operating two blast furnaces, with an average of one in operation continually, at their smelting works, Nickelton, Ont., and the refinery at Deschenes, Que., continued in operation throughout the year.

Previous to the war, 50 per cent. of the nickel production went to the steel makers for armament purposes. In 1922 only 12 per lent. went to the steel makers, and 87½ per cent. for the production of non-ferrous alloys and pure nickel products. The International Nickel Co. has been carrying on an advertising campaign to promote the use of "Monel" metal, and much research has been conducted on "nickel-bearing type of stainless steel," "seamless nickel tubes," and nickel-silicon steel, etc. The Mond Nickel Co. has been undertaking considerable construction during the year. They have increased the capacity of their

concentrator at Coniston, and are building a new addition to the smelter, installing an additional blast furnace and converter. The British America Corporation at Nickelton has the foundation in for an additional blast furnace and converter. The International Nickel Co. at Copper Cliff has installed a Dwight Lloyd sintering unit as an addition to their smelter.

The production of cobalt will show a marked increase over 1922. It should compare favourably with the year 1917, when 1,079,572 lbs were produced. The mines at Cobalt, Ont., and vicinity, are the chief sources of the world's supply. The ores, concentrates, and residues from the mines and mills of the Cobalt district are treated in the reduction plants at Deloro, and Thorold, Ont., for the recovery of the cobalt in the form of metal, oxide, and cobalt salts. Cobalt metal is chiefly used for the manufacture of "Stellite," and as one of the main constituents of permanent magnets. The oxide is used mainly for colouring in the ceramic and enamel industries, and in the preparation of the salts. The salts are used as driers in paints and varnishes and in stains in the ceramic industry.

Lead and Zinc.

The market for lead and zinc has continued strong throughout the year. The production of both metals will practically be the same as in 1922. The chief producer is the Consolidated Mining and Smelting Co. of Canada, Trail, B.C., and the source of this production is from the mines of the Slocan and East Kootenays. Besides operating their works for the reduction of their own ores and concentrates, custom ores are bought from the smaller producers of British Columbia under a very favourable schedule of prices and treatment charges. The company has completed its new concentrator at Kimberley, B.C., for the separation of the minerals of the Sullivan ore. This concentrator, which is probably the largest and most complete of its kind in the world, is a monument to the engineering skill and technical ability of the officers of the company responsible for its erection. It has a daily capacity of 3,000 tons of ore, was put into operation on August 24, and from the start gave more efficient operation as to recoveries and grade of concentrate than the concentrator of Trail formerly used for the treatment of Sullivan ore, and which is now being used for the treatment of Rossland ores. In October it was treating 2,000 tons of ore daily, and with all the equipment in operation should easily reach the 3,000 ton mark. The lead and zinc concentrates are shipped to Trail, the saving in freight charges as against the former practice of shipping the ore being an important item of expense eliminated.

Silver.

The production of silver for 1923 will approach closely to that of the preceding year. Ontario will show a greater production, but this will be offset by a slightly decreased production in British Columbia. The chief producers in Ontario are the Nipissing Mining Corporation, Keeley, O'Brien, and Coniagas. In British Columbia, the chief producers are the Consolidated Mining and Smelting Co. of Canada, mainly from the silver-lead ores of the Slocan and the Premier Mine at Stewart in the Yukon, shipments of seventeen carloads of high-grade ore have been made from the Mayo district.

Gold.

Although there has been much activity in prospecting and in the development of gold properties, the production for 1923 will hardly equal that of 1922. This is due largely to the power shortage during the first six months of the year in Northern Ontario, when operations were very considerably curtailed by the large producers. This condition has been remedied by the addition of two new hydro-electric plants on the Mettagami and Montreal rivers, and will be urther improved in the future by the plant on the Quinze river, which is under construction, and by the Hollinger Consolidated developing its own hydro-electric power on the Abitibi river. Several new plants and additions to existing plants have been put into operation during the year.

The Outlook for 1924.

The iron and steel industry has shown a decided improvement, which should continue throughout the new year. Large scale construction and the re-entry of the railroads into the markets for equipment of all kinds will be responsible largely for increased activity. An inventory of the resources of British Columbia is being made, having in view the establishment of an iron and steel industry on the Pacific Coast. In Ontario, a bounty of one cent per unit is proposed by the Ontario Government. The effect of such a bounty will be to stimulate the production of iron ore in the province.

The outlook for copper and nickel is not so bright. There seems to be an over production again of these two metals. Curtailment of production has already taken place,

Market conditions are such that a decided betterment cannot be looked for in the immediate future. Lead and zinc are in the strongest position of any of the base metals. The markets for these metals have been firmly established. There is a brisk demand for zinc ores in England. The operating companies are now in a position to increase production. Canadian ores are for the most part ores of both metals, and in many cases carry high values in silver, and in some cases, gold. While the metallurgical treatment is more difficult, they have certain advantages over less complex ores as regards market conditions.

Developments during the past year in South Lorrain, in Cobalt, and in Gowganda, Ont., in the Mayo district, Yukon, and in the Stewart and Slocan districts, British Columbia, have been such that the prospects for an increased production of silver are most encouraging. The activity in gold mining, and the exploration and development carried on during the past three years has brought many mines to the stage of production. Northern Ontario is now producing at the rate of $2,100,000 a month. With an ample supply of power, and with new producers, the Ontario production should be approximately $30,000,000 for the year 1924. Developments in the Stewart district, the opening up of the Rossland mines, increased activity in placer mining, and with improvement in the copper situation, a greater production should be recorded from British Columbia.

The great possibilities for the mining and metallurgical industry in the Dominions are being recognised by those in control of capital in other countries, so that we can look forward to a steadily increased production in the future.

THE IMPORTANCE OF COAL AS RAW MATERIAL.

No industry contemplates with equanimity an advance in the price of any of its raw materials, however small a part any of these may play in the cost of the manufacture of the final product. But an industry, such as the gas industry, which depends entirely upon coal as its raw material, does positively regard with alarm any suggestion of an advance of price.

The reason for this is not far to seek. The cost of coal constitutes one of the principal items in the cost of gas.

Since the termination of the war, gas undertakings have made energetic attempts to reduce the price of gas to something approaching the pre-war figure. They have recognised that if trade and industry were generally to recover, it was imperative that the selling price of one of its necessities should be sensibly reduced as speedily as possible. Evidence is not wanting to show that they have been signally successful in their endeavour. Naturally, they cannot but regard with misgiving any circumstance whic his calculated not only to arrest the progressive reduction of price, but which will involve an advance.

The number and variety of the industries which gas undertakings serve are not generally appreciated. If an advance in the price of coal is made, then obviously this increase will be passed on by the industries affected, as these industries must cover themselves.

But with every desire to be fair, it not infrequently happens that in the process referred to, a progressive increase of price ensues. In other words, if the price of coal is advanced, not only will the gas industry suffer, but all industries in turn will suffer, and the public will suffer most of all.

Trade depends essentially on free and unrestricted exchange. An advance of price has the effect of obviating freedom of exchange, and in so far as this occurs, trade manifestly suffers. Advances are infectious, and if an increase in the price of coal —the life-blood of the nation—is to be made, the effects are bound to be far-reaching.

But an advance in the price of coal will necessarily affect the prices of other fnels.

The heavy chemical industry will be hit very hard. Fuel is largely employed in the production of steam, which is used as such in distillation, evaporation, and many such operations, as also for the generation of motive power.

Apart from this, fuel is used by the heavy chemica industry for a variety of other purposes.

Similarly, the intermediates and fine chemicals industries will suger very materially. In the process of manufacture of these products, motive and hydraulic power, compressed air, large volumes of cooling water and gas are required, all of which necessitate the use of coal at some stage or other. Moreover, solid fuel is consumed at many stages of the process.

BRITISH DYES PROPOSAL.

Regarding the negotiations between the British Dyestuffs Corporation and the Interessen Gemeinschaft, with a view to a working agreement, a protest was made against its ratification by a deputation from the British Association of Chemists, which was received by the President of the Board of Trade, the Rt. Hon. Sidney Webb, M.P., Major A. G. Church, D.S.O., M.C., M.P., Parliamentary Private Secretary to the President, and Mr. Percy Ashley, C.B. The deputation was introduced by Mr. C. S. Garland, and included Messrs. J. T. Allpas, J. Barr, E. M. Marchant, and A. Stewart Mills.

Mr. Sidney Webb stated that the present Government had the greatest sympathy and appreciation for the labours of scientific workers. The future, not only of this nation, but of civilisation, was to a large extent in their hands, and the problem facing statesmen of all countries was that of reconciling scientific progress with the social and economic aspirations of the community. He was not certain whether the deputation were in possession of that solution of all economic problems, the application of the infinite resources of atomic energy to production and social needs, but he was conscious that it was in the direction of the utilisation of hitherto undiscovered forces that progress would be made, and he was confiden that the world in the year 2000 A.D. would be as different from the world of 1924 as the world of to-day differed from that of a century ago. He did not visualise in the immediate future the possibility of scientific men being placed in control of the whole administrative machine; the scientific man must for a long time at least depend upon the lay administrator and the representatives of democracy, politicians, liaison officers, and the interpreters of the conscious consent of democracy.

The deputation expressed concern for the future of the organic chemical industry if the terms of the proposed agreement were as announced. The possibility of the British Dyestuffs Corporation becoming the mere agents for the United Kingdom for the I.G. must have a disastrous effect upon the industry in this country and completely reverse the policy of H.M. Government with regard to the building up of the industry which was regarded as one of our first lines of defence in peace and war. The dyestuffs industry is the only trading ground for technical chemists. The dyestuffs industry is not merely concerned with the manufacture of dyestuffs, but is at the basis of the whole organic chemical industry with its innumerable products applied to services of the community in the most diverse spheres. The examples given of the products of the organic chemical industry included those used in general medicine and public health, in treatment of tropical diseases, in surgery, in the perfumery industry, in the vulcanisation of rubber, photographic chemicals and munitions of war. The comparative failure of the British Dyestuffs Corporation was attributed to the want of appreciation of science, and the attitude of hostility to the technical directors of the Board by those whose interests are purely commercial, and a plea was made for the strengthening of the scientific direction of the Corporation. In marked contrast to the failure of the British Dyestuffs Corporation, figures were given where the dyestuffs industry of this country had carried on successfully and profitably under the direction of scientific men. In one case stated figures were given where production had been quadrupled since the year 1920, and the scientific staff correspondingly increased. The point was emphasised that the superiority of the German Dyestuffs Corporations was due to the scientific direction and appreciation of scientific work in Germany, and that if the same condition prevailed in this country we need not fear German competition, given the necessary protection which has been promised under the provision of the Dyestuffs Act.

In reply it was stated that no definite agreement had been submitted to the Board of Trade, and that before any such statement could be ratified it would have to be ratified by the shareholders of the British Dyestuffs Corporation at a general meeting, and would require the approval of H.M. Government. Before that approval could be given, full consideration would be given to all parties interested. A full consideration would be given to the points now raised by members of the deputation, and the interests of dyestuffs makers other than the British Dyestuffs Corporation.

U.S. ENQUIRIES FOR CHEMICALS.

A firm at New Orleans is desirous of receiving quotations for the following chemical products:

Fine Chemicals.—Iodine, potassium iodide, sodium iodide, potassium bromide, sodium bromide, and others.

Heavy Chemicals.—Epsom salt, carbonate of soda, chloride of lime, calcium chloride, bicarbonate of soda, cream of tartar, citric acid, etc.

Firms in a position to supply United Kingdom products, as specified, can obtain further particulars from the Department of Overseas Trade, 35, Old Queen Street, London, S.W.1.

PROCEEDINGS AND NOTICES OF SOCIETIES.

THE ROYAL SOCIETY.

THURSDAY, FEBRUARY 28, 1924.

Papers read:—

O. W. RICHARDSON, F.R.S. *Thermodynamics of Electron Emission.*

This paper establishes the relations which hold, at a transition point between two condensed phases of any substance, between the various quantities which enter into the thermionic formulæ.

The universal constant which enters into the emission formula is discussed. If this quantity is exactly, and not merely approximately, constant, it is necessary that the thermo-electric powers of pairs of metals should vanish at the absolute zero, a conclusion which is almost certain on other grounds.

The recent accurate measurements of Davisson and Germer require the kinetic energy of the electrons which carry the current inside the metal to be practically independent of temperature, and are definitely against the classical type of theory of metallic conduction. They are also in good agreement with the author's formula for the temperature coefficient of the internal latent heat of evaporation of electrons.

W. A. BONE, F.R.S., D. M. HEWITT and D. T. A. TOWNEND. *Gaseous Combustion at High Pressures.—Part IV. Influence of Varying Initial Pressures on Rate of Pressure Developments, Etc.*

The principal points established were as follows:—

(1) That whereas in exploding such mixtures as normal hydrogen-air ($2H_2 + O_2 + 4N_2$) or a $2CO + O_2$ "knall-gas" (whether undiluted or diluted with excess of oxygen or argon), an increase in the initial pressure shortens the time required for the attainment of the maximum pressure, the reverse is the case with normal CO-air ($2CO + O_2 + 4N_2$) mixtures, where t_m progressively increases from 0.07 sec., when P_i = 3 atms. to as much as 0.45 sec. when it is 100 atmospheres.

(2) There is no appreciable "activation" of nitrogen in the explosion of a normal CO-air mixture at an initial pressure of 3 atmospheres or less; it is, however, distinctly recognisable at an initial pressure of 10 atmospheres, and thereafter increases with the initial pressure, until at 50 atmospheres and higher it becomes a very marked feature of the explosion phenomena.

(3) Such N_2-activation in a CO-air explosion is a radiation effect, being probably due to the similar electronic configurations of N_2 and CO molecules; moreover, it precedes any NO-formation in the flame, which latter is a secondary effect consequential upon the primary N_2-activation, whose magnitude largely depends upon there being an excess of oxygen in the mixture exploded.

(4) The amount of NO surviving in the cooled products when a $2CO + 3O_2 + 2N_2$ mixture is exploded at an initial pressure of 75 atmospheres is about thirty times greater than that surviving in the case of the products of the isothermic ($2H_2 + 3O_2 + 2N_2$) mixture exploded at the same pressure, although the conditions as regards total energy development and relative concentrations of combustible gas, oxygen, and nitrogen are precisely the same, and the maximum temperatures (about 3,020° and 2,820° abs.) nearly so, in the two cases.

(5) Speaking generally, no appreciable "after-burning" occurs when mixtures such as these investigated are exploded at initial pressures of 10 atmospheres or higher; nor is the maximum temperature in the explosion of an undiluted $2CO + O_2$ "knall-gas" at such initial pressures limited by the dissociation of carbon dioxide, although in certain cases it exceeds 5,200° abs.

J. E. P. WAGSTAFF. *An Electrical Method of Determining the Velocity of Detonation of Explosives.* Communicated by Sir Robert Robertson, F.R.S.

Paper read in title only:—

W. L. BRAGG, F.R.S. *The Refractive Indices of Calcite and Aragonite.*

Calcite and aragonite, two crystalline forms of calcium carbonate, are closely related in their optical properties. Both

crystals possess strong negative birefringence, and their refractivities are nearly identical when allowance is made for the small difference in molecular volume between the two. The crystals have been analysed by X-ray methods.

The strong double refraction is to be ascribed to the peculiar form of the CO_3 group. This consists of three oxygen atoms grouped around a central carbon atom and lying in a plane. The oxygen atoms are more highly polarised by an electric field than the other atoms in the crystal. The three atoms in the same CO_3 group, when they become electrical doublets, exert a strong influence on each other, which results in their being more strongly polarised by an electric field parallel to the plane of the group than by a field perpendicular to the plane of the group. Hence the refractive index of the crystal is greater when the electric vector is perpendicular to the trigonal axis of calcite than when it is parallel to the axis. The same holds for the pseudo-hexagonal axis of aragonite.

A numerical calculation of the effect shows that it accounts quantitatively for the difference in refractive indices, both for calcite and aragonite. Values for the refractivities of the calcium and oxygen atoms are assumed which are based on the refractivity of a number of compounds. When these are substituted in the formulæ which are derived, the calculated values of the refractive indices do not differ by more than 1 or 2 per cent. from the observed values. Thus:—

	Calculated.	Observed.
Calcite ϵ	1.488	1.486
,, ω	1.631	1.658
Aragonite α ...	1.538	1.530
,, β ...	1.694	1.681
,, γ ...	1.680	1.686

THE ROYAL SOCIETY OF ARTS.

On Monday, March 3, the second Cantor lecture, entitled *A Study of the Destructive Distillation of Coal,* was delivered by Edward Victor Evans, O.B.E., F.I.C., Chief Chemist and Products Manager of the South Metropolitan Gas Company, London.

On Tuesday, March 4, a meeting of the Dominions and Colonies Section was held. A paper entitled *Empire Oil: The Progress of Sarawak,* was read by the Hon. T. G. Cochrane, D.S.O. The Right Hon. Lord Bearsted presided.

On Wednesday, March 5, at the ordinary meeting, a paper entitled *Building and Decoration of the War Cemeteries* was read by Major-General Sir Fabian Ware, K.C.V.O., K.B.E., C.M.G., C.B., Vice-Chairman, Imperial War Graves Commission. Lord Askwith, K.C.B., K.C., D.C.L., Chairman of the Council and a Vice-President of the Society, presided.

THE ROYAL INSTITUTION OF GREAT BRITAIN.

The Friday evening discourse on March 7 was delivered by Walter Rosenhain, D.Sc., F.R.S., on *The Inner Structure of Alloys.*

On Tuesday, March 4, Prof. Joseph Barcroft, F.R.S., gave his fourth lecture on *The Respiratory Pigments in Animal Life and Their Significance.*

On Thursday, March 6, John S. Flett, F.R.S., gave a lecture on *Modes of Volcanic Action.*

On Saturday, March 8, Sir Ernest Rutherford, F.R.S., will give a lecture on *Properties of Gases in High and Low Vacua.*

SOCIETY OF PUBLIC ANALYSTS AND OTHER ANALYTICAL CHEMISTS.

A meeting of the Society was held on March 5, when the following papers were read:—

The Composition and Examination of Beef and Malt Wine, by G. D. Elsdon, B.Sc., F.I.C.

The Determination of Coconut Oil in Margarine, by G. D. Elsdon, B.Sc., F.I.C.

Effect of Fatty Diet on the Composition of Butter Fat, by J. C. Drummond, D.Sc., F.I.C., and H. J. Channon, B.A., B.Sc.

What is Bondon Cheese? by G. D. Elsdon, B.Sc., F.I.C.

Cream Cheese, by T. R. Hodgson, M.A., F.I.C.

Some Facts on the Composition and Decomposition of Eggs, by R. T. Thompson, F.I.C., and J. Sorley, F.I.C.

THE CHEMICAL SOCIETY.

ORDINARY SCIENTIFIC MEETING, THURSDAY, MARCH 6.

The following papers were read:—

The Reaction between Lime and Nitrogen Peroxide, by J. R. PARTINGTON and F. A. WILLIAMS.

Tellurium Monoxide, by J. J. DOOLAN and J. R. PARTINGTON.

The Dimorphism of Diphenylarsenious Chloride (diphenylchloroarsine), by C. S. GIBSON and (the late) D. C. VINING.

The Isomerism of the Oximes.—Part XVII. The Action of 2:4-Dinitro-Chloro-Benzene on some Isomeric Aldoximes, by O. L. BRADY and R. TRUSZKOWSKI.

THE MINERALOGICAL SOCIETY.

FEBRUARY 19.

Dr. A. E. H. Tutton, past-President, was in the chair.

The following papers were read:—

F. N. ASHCROFT. *Mineral Localities in the Tavetschthal, Switzerland.*

An account of a number of localities in the Tavetschthal, *i.e.*, the uppermost part of the valley of the Vorder Rhein, and in the neighbourhood of Disentis, a little further down the river, visited by the author in 1922 and 1923, was given. The geological features and the mineral associations characteristic of each locality were described.

E. D. MOUNTAIN. *A Specimen of Calcite from the Bryn-gwiog Mine, near Holywell, Flintshire.*

Collected by W. Campbell Smith in 1923, this consisted of crystals of two distinct habits. These were pyramidal, with the uncommon hexagonal bipyramid L (88.16.3) = (917) predominant; and prismatic, with acute rhombohedral termination. Both habits are sometimes developed on the same crystal.

CORRESPONDENCE.

TEST FOR ARSENIC—A CORRECTION.

To the Editors of THE CHEMICAL NEWS.

SIRS,—A short time ago I published a paper (see *The Chemical News*, this vol., pp. 103-104), in which the arsenical fusion of 4′ Amino-1-phenyl-5-methylbenzothiazole was discussed. A product was isolated which gave a qualitative test for arsenic (arsine test), and which differed from the original substance by its insolubility in boiling alcohol. Later experiments have shown that the arsenic is only present as an impurity, probably as a trace of the arsenate of the base, and the substance is not, as was suggested, a possible higher analogue of atoxyl. Further, refluxing with excess of ethyl alcohol for a considerable period of time produces a solution from which yellow crystals can be obtained. It is now believed that the substance described in Part IV. of this work was nothing more than an impure form of dehydrothiotoluidine. This penomena of insolubility in ethyl alcohol, followed by solution, after an hour's refluxing, or so, has already been noted in the case of the dibrom addition product of 4′-amino-1-phenyl-5-methylbenzothiazole, and is apparently a property of this class of sulphur compounds.—Yours, &c.,

R. F. HUNTER.

South Kensington.
February, 1924.

SIR WILLIAM CROOKES.

SIRS,—I beg the hospitality of your columns for the following:—

In the life of the above eminent scientist, by Mr. Fournier d'Albe, it is stated (page 392) that his son, the late Henry Crookes, was made bankrupt, and that his father was unwilling to save him from that experience.

These two statements are entirely incorrect, and Mr. d'Albe has expressed his regret for their appearance, and has undertaken that the erroneous allegations will be omitted from future editions of his book and corrections made in all unsold copies of the existing edition.

These calumnies have, however, travelled far and wide, and I am advised that I have no means of publicly correcting them except by the kindness of the Press, as libellous

statements about those who have passed away, however painful to those they have left behind, are not recognised by the law as subject matter for action in the Courts.—Yours, &c., M. G. CROOKES.

(Widow of the late Henry Crookes).

24, *Ladbroke Gardens*, W.11.
February 18, 1924.

NOTICES OF BOOKS.

Chemische Grundbegriffe—The Fundamental Ideas of Chemistry, by DR. ALFRED BENRATH, translated by JETHRO BITHELL, M.A. Pp. 81 + 81. London: Messrs. G. Harrap & Co., Ltd., 39-41, Parker Street, Kingsway, W.C.2. 1924. 2s. net.

The object of this bilingual (left page German, right page English) book is to afford science students an opportunity of acquiring a working knowledge of technical German without having to go thoroughly into the grammar.

The selection of Prof. Benrath's little treatise, published in the excellent *Sammlung Göschen*, is a good one, since it deals with the basis of chemical theory in a clear and interesting way. The student is thus enabled to revise his scientific knowledge whilst he is acquiring the rudiments of another language.

The subject matter is treated historically. The author gives an account of the conceptions of the Element and the Atom, the molecular theory, and finally a long chapter entitled "Chemical Formulæ," which touches upon many problems in inorganic and organic chemistry. One or two minor slips have been noted; ammonia addition compounds are *ammines*, not *amonines* (p. 78).

The translator has adhered faithfully to the original text, thereby adding to the value of the book from the students' point of view. J.G.F.D.

The Microscope, Part II—An advanced Handbook, by CONRAD BECK, C.B.E. Pp. 231 (170 figs.). London: R. & J. Beck, Ltd. 7s. 6d. net.

This book is Part II. of a handbook on the microscope, of which the same author's "The Microscope—A Simple Handbook," published in 1923 (see *The Chemical News*, 1922, CXXV., 256) forms the first part.

The aim of the book is to explain the optical principles upon which the microscope is based, without recourse to advanced mathematics. The nine chapters include as subjects: The geometric optics of the microscope; the correction of lenses; aperture and resolution; the photometry of the microscope; glare and flooding; notes on illumination and technique; notes on testing microscope object-glasses; microscopes for special purposes; and polarised light as applied to the microscope. Of these, the author commends to the practical worker for particular study the sections dealing with resolution, glare and illumination.

That "things are not what they seem" is known to any experienced investigator: this obtains perhaps more in microscopy than in many subjects, and the author points out some of the pitfalls that beset the path of the unwary.

Four conditions are laid down which must be fulfilled in order to obtain the best results in high power work with transparent illumination. The whole aperture of the object glass should be filled with light; the light should be equally distributed over the whole aperture; the central portion only of the field should be illuminated; and the light should not be thrown upon the object at a greater angle than is required to fill the aperture of the object-glass in order to reduce glare.

The development of many subjects is restricted to a more or less degree by the development of the microscope, and in view of many modern trends, the information on the best use of the methods of dark ground illumination, of high power opaque illumination (as in metallurgy), and ultra-microscopy has made it perhaps one of the most promising methods of modern science; quite apart from the fact that fine particles in suspension in fluids can be examined and their behaviour followed (as for example during a chemical reaction), many solid bodies contain particles of ultra-microscopic size, the study of which is highly important both to the chemist and petrologist.

One of the many valuable features of the book is the chapter on polarised light, giving a concise account of the theory of polarisation, and some practical petrological applications. Goniometers and refractometers principally for petrological work are discussed. The chapter on microscopes for special purposes will prove of particular in-

terest. It frequently occurs that a worker on an industrial problem requires a special instrument to aid in its elucidation: many such are described. For example, there is a special inverted microscope for certain chemical work.

A list of apparatus and a good index complete an excellent book, that is essentially a book for the working microscopist, not a list of instructions for the man who will spend eight hours adjusting a microscope, and only one minute looking at an object.

A number of books on microscopy already exist, but Mr. Beck's manner of treating his subject makes his book fill a long-felt want. E.H.E.

The Chemists' Year Book, by F. W. ATACK, M.Sc.Tech., D.Sc. (Manc.), B.Sc. (Lond.), assisted by L. WHINYATES, A.M.C.T., A.I.C. Pp. 1147. Manchester: Sherratt & Hughes, 34, Cross Street. 1924. 21s. (abroad 22s. post free).

This issue, the ninth, of the English equivalent of the *Chemiker Kalender*, has the advantage of being in one volume. The collaboration of F. M. Turner, technical editor of the Chemical Catalog Company, has enabled more American data to be incorporated in this edition.

New sections have been added on "Water Analysis," by S. E. Melling, F.I.C.; "Essential Oils," by T. H. Durrans, M.Sc., F.I.C.; and "Spirits," by F. Robinson, M.Sc., F.I.C.

Other sections, written by specialists, have also been revised in accordance with the latest knowledge.

Differential Equations in Applied Chemistry, by FRANK LAUREN HITCHCOCK, Ph.D., and CLARK SHOVE ROBINSON, S.M. Pp. VI. + 110. London: Chapman and Hall, Ltd., 11, Henrietta Street, W.C.2. 1923. 7s. 6d. net.

The object of this little volume is to present the necessary mathematics to chemistry students in an easily assimilated form. The needs of the chemist and chemical engineer are kept in mind throughout, and the examples are taken from familiar subjects.

Commencing, after an introduction, with processes of the first order, the authors go on to those of the second order, simultaneous reactions, opposing and consecutive processes, equations of flow and graphical evaluations of integral expressions. There is also a short section showing how to find the best line through a set of points.

Answers to the questions are not given.

An elementary knowledge of the various branches of mathematics, including calculus, is assumed. The book deserves the careful attention of chemists.

BOOKS RECEIVED.

Building for Peace II.: International Letters, by WILLIAM ALBERT NOYES. Pp. 78. 1924. Messrs. Heffer & Sons, Ltd., 4, *Petty Cury, Cambridge*. 1s. 6d. net.

A Text-Book of Inorganic Chemistry, by J. NEWTON FRIEND, D.Sc., Ph.D., F.I.C. Pp. XVII. + 370. Vol. III., Part I. 1924. Messrs. Charles Griffin & Co., Ltd., Exeter Street, Strand, W.C.2. 18s. net.

BRITISH EMPIRE EXHIBITION.

The following pamphlets of interest to chemists in particular and the public in general are being prepared:—

Chemical Research in General; Food; Fermentation; Alkali, Acid, Soap, etc., Dyes; Fine Chemicals; Wood Products; Ceramics; Rare Earths; Carbonisation of Coal; Buildings; Air and Water.

A companion book to the exhibits in chemical science at the British Empire Exhibition, to be called *Chemistry in the Twentieth Century*, is being compiled. It is hoped that this will afford a permanent record of the exhibition from the chemical standpoint. The following sections will be described:—

Introduction, Dr. E. F. Armstrong, F.R.S.; X-Ray Analysis, Sir William Bragg, F.R.S.; The Structure of the Atom, Sir William Bragg, F.R.S.; Valency Theories, Prof. Lapworth, F.R.S.; Crystallography, Sir Henry Miers, F.R.S., and T. V. Barker; General Physical Chemistry, Dr. Masson; Spectroscopy, Prof. Baly, F.R.S.; Catalysis, Dr. Hilditch; Colloids, Dr. W. Clayton; Rare Gases, Dr. Travers, F.R.S.; Alloys, Prof. Desch, F.R.S.; Flame, Fuel, Explosion, Dr. Seward; Organic General, Prof. J. F. Thorpe, F.R.S.; Alkaloids, Prof. Pyman, F.R.S., and Dr. Henry; Sugars, Principal Irvine, F.R.S.; Terpenes, Prof. Henderson, F.R.S.; Coal Tar Colours, Prof. Green, F.R.S.; Natural Colours, Mr. Ru-

ness; Fats, Mr. J. Allan; Biochemistry, Dr. Plimmer; Fermentation, Dr. Harden, F.R.S.; Agricultural Chemistry, Sir J. Russell, F.R.S.; Agricultural Chemistry, Dr. Page; Photographic Chemistry, Dr. Slater Price; Cellulose, Dr. F. Cross, F.R.S.; Explosives, Sir R. Robertson, F.R.S.; Refractories, C. W. Thomas.

PUBLICATIONS RECEIVED.

U.S. Department of Commerce, Bureau of Standards.

Recommended Specification for Quicklime and Hydrated Lime for use in the Manufacture of Sand-Lime Brick. Pp. 2 to 6.

A Measure of the Colour Characteristics of White Papers, by R. E. Lofton. Pp. 667 to 676.

Embrittlement of Malleable Cast Iron resulting from Heat Treatment, by Leslie H. Marshall. Pp. 677 to 693.

Wet-Process Enamels for Cast Iron, by R. R. Danielson and H. P. Reinecker. Pp. 695 to 735.

U.S. Department of the Interior, United States Geological Survey.

Secondary Metals in 1922, by J. P. Dunlop. Pp. 173 to 191.

Gold, Silver, Copper and Lead in South Dakota and Wyoming in 1922, by C. W. Henderson. Pp. 193 to 198.

Barytes and Barium Products in 1922, by George W. Stose. Pp. 141 to 152.

Mica in 1922, by B. H. Stoddard. Pp. 153 to 164.

Slate in 1922, by G. F. Loughlin and A. T. Coonds. Pp. 165 to 175.

Sulphur and Pyrites in 1922, by H. A. C. Jenison and H. M. Meyer. Pp. 177 to 181

Silica in 1922, by Frank J. Katz. Pp. 183 to 186.

Lime in 1922, by G. F. Loughlin and A. T. Gonns. Pp. 195 to 206.

A New Fauna from the Colorado Group of Southern Montana, by B. Reeside. Pp. 30.

Notes on the Geology of Green River Valley between Green River, Wyoming, and Green River, Utah, by John B. Reeside Pp. 35 to 50.

The Correlation of the Vicksburg Group, by C. Wythe Cooke; and *The Foraminifera of the Vicksburg Group*, by Joseph A. Cushman. Pp. 71.

CALCIUM ARSENATE—MONOPOLY ABSURDITY.

By H. W. Ambruster.

For the insecticide manufacturers the experience of the last decade has been a nightmare; at this time it has great resemblance to a brain-storm.

Let us take a look at the insecticide industry of the past, a violently fluctuating raw material, a costly plant investment with methods constantly changing, a poisonous plant to operate, a thousand entomologists to satisfy as to what to make, a watchful Federal Government to check the quality and the spelling on the label, a seasonal shipping schedule at best and orders ranging from half-pound cartons and up, with sometimes a carload, and, finally a marketing problem to solve, consisting of violent competition for the trade of farmers, who cannot tell what they will need until the bugs actually come, and dealers or jobbers, who, mostly, do not gamble.

It is a pretty dismal picture, isn't it? But it is a true one, and let us face the facts. You cannot expect these insecticide manufacturers by themselves to hold the umbrella over the cotton fields while any such cyclone as is now in progress exists. You have got to help stabilise things somehow, and the first step is to get rid of the thought that combinations and speculators are responsible for the present condition in the arsenical industries. I am betraying no confidence when I state to you my own belief that the arsenic producers are not sufficiently interested in this product to even consider either speculation or combination. As for the insecticide manufacturers—well, to put it mildly, they don't like each other sufficiently well to combine, even if they were inclined to do so, and they speculate only as any other manufacturer must. They either buy their raw materials a long way ahead or they don't.

The talk of an arsenic corner among dealers and importers is absurd, because the total quantity coming in from abroad is negligible in face of the potential demand existing. I recall being asked by an official of one of the smelters about nine months ago what I thought of the prospects on arsenic. I told him that I thought they looked bad for him and his company. He seemed surprised at this answer, and demanded my reason. My reply was substantially this:—"If your company sells ahead into next season at present prices, later, when you

haven't got any left to sell at much higher prices, you will surely be called mean names by those who want to buy; and if you don't sell now but hold your production until later and then get then get the prices that will then prevail, you will also be called mean names." Well, he got called the names all right, and I happen to know that that company didn't get anything like present prices on their output.

(To be continued.)

New Patents.

This list is specially compiled for *The Chemical News* by Messrs. Rayner & Co., Registered Patent Agents, of 5, Chancery Lane, London, from whom all information relating to Patents, Trade Marks, and Designs can be obtained gratuitously.

Latest Patent Applications.

3766—Bichowsky, F. Von.—Method for production of cyanogen compounds. Feb. 13.

3800—Canada Carbide Co., Ltd.—Manufacture of sodium sulphide. Feb. 14.

3529—McDavid, J. W.—Recovery and concentration of nitric acid. Feb. 11.

3702, 3703—Stewart, R. E.—Purification of cresylic acid. Feb. 13.

Specifications Published this Week.

210545—Davies, W. Rhys, and Haigh, T.—Scouring, bleaching, dyeing, wet-acid carbonising, and like operations on wool and other fibrous materials.

210628—Sandstrom, C., and Tirziev, G. N.—Process of manufacture of a sodium compound.

199713—Titan Co. Aktieselskabet.—Treatment of titanium-nitrogen compounds.

Abstract Published this Week.

208929—Alkali pentaborates.—Kelly, A., of 57, Chancery Lane, London.

Boron ores with addition of alkali, if necessary, are treated with a solution of a metal sulphate other than sodium sulphate or acid sodium sulphate capable of effecting their decomposition with the production of alkali pentaborate. Boro natro-calcite may be treated with ferric sulphate or aluminium sulphate solution. When ferric sulphate is used, any arsenic present in the ore remains with the sludge of calcium sulphate and ferric hydro-oxide produced.

Messrs. Rayner & Co. will obtain printed copies of the published specifications and abstract only, and forward on post free for the price of 1s. 6d. each.

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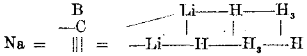
THE CHEMICAL NEWS,

VOL. CXXVIII. No. 3335.

THE CONSTITUTION AND STRUCTURE OF AN ATOM OF SODIUM.

BY HAWKSWORTH COLLINS.

All the following numerical facts demonstrate that an atom of sodium has been formed by the union of one of carbon with one of boron in the following manner:—



The three valences of boron have combined with three of carbon, leaving one free, so that sodium is monadic. In addition to this, at least one atomising bond has come into play which is represented by the thin line between the two lithium portions.

The atomic weights of B, C, and Na are 11, 12 and 23 respectively; and 11 + 12 = 23.

Sodium cannot act as a non-metal, as there is no free H - H_3.

TABLE I.

The Relative Volumes of Sodium.

Na		B		C
23.7	=	15.7	+	8
11.85	=	3.85	+	8
9.54 (as part of an atom)	=	3.85	+	5.69

The last volume was partly demonstrated in the preceding paper (this vol., p. 145-147, Mar. 7), and will be shown to come into the constitution of other elements later.

TABLE II.

Experimental data demonstrating the Volumes of Table I.

		Theor. S.G. at 15° C.	Obs. S.G.
(51)	Na 23.7	0.97	0.97 Troost & Hautefeuille
(52)	Na_3AsO_4. 3(11.85) + 19.58 + 7.53 + 4.45 + 2(2.51)	2.88	2.86, 21° Stallo ∴ 2.875, 15°
(53)	Na_3AsO_4 + $12H_2O$ 3(11.85) + 19.58 + 7.53 + 4.45 + 2(2.51) + 12(14.03)	1.763	1.762 Schiff
(54)	NaCl 11.85 + 15.085	2.17	2.17, 20° Kaye 2.15 Kopp
(55)	NaBr 11.85 + 23.09	2.95	2.952 Schiff
(56)	NaBr + $2H_2O$ 11.85 + 23.09 + 2(14.03)	2.20	2.176, 20°/4 Van Nostrand ∴ 2.186, 15°
(57)	$NaNO_3$ 11.85 + 3.8 + 3(7.53)	2.223	2.2256 Karsten 2.182 Playfair & J.
(58)	B_2O_3 (2(15.7) + 3(2.51)	1.80	1.803 Davy 1.75 Breithaupt
(59)	B_2S_5 2(15.7 + 10.51) + 3(15.53)	1.84	1.85 Van Nostrand
(60)	BCl_3 15.7 + 3(23.01)	1.387	1.35 Wohler 1.434, 0°/4 Nostrand
(61)	Triethyl borate $(C_2H_5)_3BO_3$ 3(48.09) + 15.7 + 3(2.51)	0.8716	0.871 Bowman
(62)	Tripropyl borate $(C_3H_7)_3$ BO_3 3(64.51 + 15.7 + 3(2.51)	0.867	0.858, 26° Schiff ∴ 0.864, 15°
(63)	$Al_2KB_3O_8$ 12.05 + 9.05 + 22.29 + 3(3.85) + 8(2.51)	3.38	3.38 Damour
(64)	CB_6 8 + 6(3.85)	2.51	2.51 Van Nostrand
(65)	Li_2C_2 5.46 + 6.21 + 2(5.69)	1.65	1.65, 18° Van Nostrand
(66)	SiC 7.13 + 5.69	3.12	3.12, 15° Nostrand
(67)	MnSi 6.94 + 7.13	5.90	5.90, 15° Nostrand
(68)	$MnSi_2$ 6.94 + 2(7.13)	5.24	5.24, 13° Nostrand
(69)	$NaHCO_3$ 11.85 + 5.76 + 8 + 7.58 + 2(2.51)	2.201	2.205 Schroder 2.192 Playfair & J.
(70)	Na_2CO_3 2(11.85) + 8 + 7.53 + 2(2.51)	2.40	2.407 Favre

As the original volume (23.7) of sodium diminishes by exactly one half when entering into combination with other elements, its heat of formation must be 120 × 11.85 × 23 = 32706. *E.g.*, the H.F. of solid Na_3AsO_4 is

3(32706) - 35100 + 32341 + 71515 + 2(96155) = 359184. 360800 (obs.)

This corresponds exactly with No. 52 of Table II.

As this molecule contains the three different oxygen atoms, the discovery of which reduced to order thousands of numerical data in Specific Gravity and Heat of Formation, a full discussion of each numerical datum or deduction is here given as far as they concern this molecule; and similar remarks must be understood to apply to all molecules.

The elucidation of the whole matter concerning the molecule Na_3AsO_4 is equivalent to performing the following operations upon its numerical data:—

(1) Find the correct molecular volume (72.13) at 15° C., such that when the molecular weight is divided by it, the correct S.G. (2.88) of the molecule is given. The only values given are 2.8128 and 2.8577, both at 21° C. by Stallo.

(2) Split up the molecular volume into its atomic volumes. This operation involves a systematic study of all the thousands of substances given in Clarke's Table of Specific Gravity, Van Nostrand's Annual, etc. 72.13 = 3(11.85) + 19.58 + 7.53 + 4.45 + 2(2.51).

(3) Find the correct S.G. (0.97) of Na from the experimental values which vary from 0.9348 to 0.985 in Clarke's Tables, and divide the atomic weight by it, obtaining 23.7.

(4) Subtract 11.85 from 23.7, obtaining the change of volume 11.85.

(5) Multiply this change of volume by the atomic weight and by the constant 120, obtaining the H.F. 32706.

(6) Find the correct S.G. (4.783) of As from the experimental values which vary from 3.70 to 5.959 in Clarke's Tables, and divide the atomic weight by it, obtaining 15.68.

(7) Subtract 15.68 from 19.58, obtaining the change of volume 3.9.

(8) Multiply this increase of volume by the atomic weight of As and by the constant 120, obtaining the H.F. - 35100.

(9) Find the equivalent original relative volume of oxygen (10.07) and subtract 7.53 from it, obtaining 2.54 as the change of volume.

(10) Multiply this change of volume by the atomic weight and by the constant 795 for sub-sodium elements, obtaining 32341.

(11) Subtract 4.45 from 10.07, obtaining 5.62 as change of volume.

(12) Multiply this change of volume by 16 and 795, obtaining 71515.

(13) Subtract 2.51 from 10.07, obtaining 7.56 as change of volume.

(14) Multiply 7.56 by 16 and 795, obtaining the H.F. 96155.

(15) Add up 3(32706) - 35100 + 32341 + 71515 + 2(96155), obtaining 359184, which must be within 1 per cent. of the experimental value to be of any use.

(16) Find the definite structural meaning of each relative volume of Na, As and O, except that of 10.07 of oxygen, which is only the *equivalent* original relative volume, since it includes an imaginary volume, which is due to the latent heat evolved in passing from the gaseous to the solid state.

(17) Divide half the atomic weight of Na by 11.85, obtaining 0.97 for the magnetic rotation of Na in any pure substance which contains an atom of sodium. (All inorganic substances of which the M.R. is available are given in *The Chemical News*, Mar. 29, 1923.)

In *The Chemical News*, Feb. 11 and 18, and Aug. 19, 1921, 249 organic substances were discussed with the intention of showing the relative volume of each atom in these molecules, but owing to the large amount of space required for such a purwhich *The Chemical News* could not provide, the demonstration was stopped before it had proceeded far. As far as it went, the relative volumes of ethyl, H + $(CH_2)_2$, and propyl, H + $(CH_2)_3$, which come into Nos. 61 and 62 of Table II., were shown to be 15.25 + 2(16.42) = 48.09, and 15.25 + 3(16.42) = 64.51. Also the volumes of the groups, $CO_2C_2H_5$ and $CO_2C_3H_7$, were shown to be 66.13 = 18.04 + 48.09, and 82.55 = 18.04 + 64.51, so that the volume of CO_2 (which comes into Nos. 69 and 70 of Table II.) is 18.04.

The discovery of the volume which belongs to each of the three atoms in this group was sent to the Nobel Institute in 1914 (being demonstrated by means of hundreds of diagrams), as follows:—

Relative volume of C = 8
,, ,, ,, O_* = 7.53
,, ,, ,, O = 2.51

In 1922 these were proved to be exactly true by the discovery of the Law of Heat of Formation, and they were confirmed by the Correlation of Physico-Chemical Con-

stants, as sent to the Nobel Institute in 1923.

The heat of formation of $NaHCO_3$ is

$$32706 - 15300 - 13886 + 32341 + 2(96155) = 228171. \quad 227700 \text{ (obs.)}$$

and that of Na_2CO_3 is

$$2(32706) - 13886 + 32341 + 2(96155) = 276177. \quad 273700 \text{ (obs.)}$$
$$\text{H.F. aq. } 278280 \text{ (obs.)}$$

where $-13886 = 795 \times (-1.456) \times 12$, showing that the carbon atom has increased in volume from 6.544 to 8.0.

12, divided by 6.544, gives specific gravity 1.834, 15° C.

1.84 Griffith. 1.80 Playfair.

The three relative volumes of Na, 23.70, 11.85 and 9.54, are not mere approximations to the truth (except that they do not go beyond two places o decimals), but represent *the exact truth at 15° C.; for if* any attempt were made to alter any one of them (*e.g.*, to alter 11.85 to 11.87) the change would throw out of gear a whole lot of other facts, and nothing but confusion would result.

From this and preceding papers it must be evident that the exact S.G. of a substance at 15° C. has been converted into one of the best instruments of research in existence.

THE FORMATION AND STABILITY OF BROM-BENZOTHIAZOLES.

PART I.—4′ AMINO 1 PHENYL 1:9 DIBROMO 5 METHYL BENZOTHIAZOLE.

By R. F. HUNTER.

The formation of bromo addition products of the benzothiazoles has been observed by various workers. Thus Gattermann (*Berichte*, 1889), during his work on dehydrothiotoluidine, noted the formation of a dibromo product in glacial acetic acid, according to the equation:

$$C_{14}H_{12}N_2S + 2Br = C_{14}H_{12}N_2SBr_2.$$

The only part of the molecule of dehydrothiotoluidine (1) which can be regarded as unsaturated is clearly *the double bond* between the nitrogen and carbon of the fused thiazole ring. Hence we should expect this reaction to consist of the normal splitting of the double bond with the addition of bromine at the heterocyclic ring and the resulting compound, that is to say, the dibrom addition product to have the structure (2):

$$CH_3C_6H_3 \mathop{<}\limits_{N}^{S}\mathop{>}C\,C_6H_4NH_2 + 2Br =$$

(1)

$$CH_3C_6H_3 \mathop{<}\limits_{NBr}^{S}\mathop{>} CBr\,C_6H_4NH_2$$

(2)

Consider, firstly, the brominated thiazole ring. The addition of bromine has clearly given rise to a new ring system, as shown above, and it is clear that we can no longer look for the remarkable stability of the *fused thiazole ring in the new compounds*, for the addition of bromine directly to the nitrogen atom of the heterocyclic ring brings about the loss of stability from analogy with inorganic compounds having nitrogen and bromine directly linked by a single valency bond. For instance, nitrogen bromide is explosively unstable. On the other hand, the analogy is scarcely a fair one, for nitrogen bromide is an open chain compound, whereas the bromine and nitrogen in this case participate in a five-membered ring, and the five-membered ring is clearly one of the stablest ring systems, from the recent work of Ingold. The ring under consideration is also derived from the stablest of ring systems, namely, benzene, *by the substitution of nitrogen and sulphur* for carbon and hydrogen, and hence it would clearly be unreasonable to look for anything in the nature of explosive instability, for, after all, we have, by the addition of bromine, merely given rise to a new strained ring system—to be more exact, a *fused ring system* whose *instability* arises from the strained condition of the third valency of the nitrogen atom of the heterocyclic ring system, due to the direct valency linking between the bromine and nitrogen atoms. The strain in the nitrogen atom—we must regard the nitrogen atom as being to a certain extent distorted and sharing the strain of its valencies—will be communicated to the adjoining atoms of the ring via *the two remaining* nitrogen valencies, the valencies 1 : 2 and 9 : 1, using the usual method of position numbering of the benzothiazole system. Therefore, we should look for a complete loss of stability throughout the whole ring system, in this case the thiazole, or rather benzothiazole, residue.

The bromination of dehydrothiotoluidine

is, of course, visualised as the splitting of the double bond between nitrogen and carbon, followed by the saturation of these valencies with the addition of the two bromine atoms.

The nitrogen bromine link of the brom thiazole is the centre of instability, and therefore we expect a strong tendency to split off bromine with hydrolysing agents at this point. This is borne out by experiment, for if the bromo derivative is boiled with dilute alkali and the resulting solution acidified, the solution gives the usual tests for the bromine ions, that is to say, the silver halide. The greatest tendency to split off bromine is exhibited by the bromo addition product of acetyldehydrothiotoluidine, which is assumed to be 4′ acetylamino 1 phenyl 1:9 dibromo 5 methylbenzothiazole (3).

$$CH_3C_6H_3 < \overset{S}{\underset{NBr}{}} > CBr\ C_6H_4NH\ COCH_3$$

(3)

$$CH_3(NO_2)\ C_6H_2 < \overset{S}{\underset{NBr}{}} > CBr\ C_6H_4NH_2$$

(4)

for this compound splits off bromine on merely heating with water. Green was the first to notice this, although he did not isolate the brom compound. The brom compound is unstable even at ordinary temperatures, and smells of bromine. The author's analysis reveals that there is a tendency for the compound to decompose, even in a dry state, for the analysis gives figures which are low for 2Br. Some objections might be raised to the formulation of the brom addition reaction, as has been done above. The evidence can be stated briefly as follows for the above formulation in this way: firstly, the reaction on the work of Anschutz and Schultz is shown to be one of addition; secondly, the reaction has nothing to do with the amino group, for it occurs when this is blocked with acetyl or a benzaldehyde residue; thirdly, the author has isolated a brom compound in the case of nitro dehydrothiotoluidine (4) in which the nitro group substitutes in the homocyclic fused benzene ring of the benzothiazole system.

$$CH_3C_6H_3 < \overset{S}{\underset{NBr}{}} > CBr\ C_6H_3(SO_3H)\ NH$$

(5).

$$CH_3C_6H_3 < \overset{S}{\underset{NBr}{}} > CBr\ C_6H_4\ NCH\ C_6$$

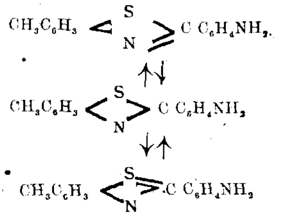
(6)

And lastly, a similar compound was isolated in the case of the mono sulphonic acid of dehydrothiotoluidine (5), where the sulphonyl group is in the phenylating part of the molecule.

Clearly, then, the addition must be concerned with the thiazole ring, since this is the only unsaturated part of the whole molecule. The double bond, however, which involves this unsaturation, is involved in a stable ring, and is therefore less unsaturated than if it were in an open chain part of a molecule, and thus the brom addition products take some time to form in one or two cases, notably in the case of the benzoylation product of dehydrothiotoluidine. Thus the benzoyl compound was dissolved in warm alcohol, the solution cooled and brominated in the usual way, the brom solution allowed to stand and then drowned in cold water, when a yellow precipitate similar to acetyldehydrothiotoluidine bromide was formed. This was filtered and washed with dilute alcohol and dried. On analysis it gave the qualitative test for bromine, on quantitative analysis, however, it was found that there was little more than a trace of bromine present. Allowing the brom solution to stand for twelve hours at room temperature, however, ensures good conversion to the brom derivative. The inhibitory action of the benzoyl group is difficult to understand as regards the formation of a brom addition product. It is possible however, that a trace of some by-product in the benzoyl compound has a negative catalysing influence, for the addition proceeds smoothly in the cases of acetyl dehydrothiotoluidine an dbenzal dehydrothiotoluidine. The relatively great instability of the brom acetyl compound is equally hard to understand.

The suggestion has been put forward by the author that in alcoholic solution of dehydrothiotoluidine, at least under the action of ultra-violet light, we are dealing with a three-phase tautomeric system involving intra-nuclear tautomerism and valency ex-

change across the heterocyclic ring of the form given hereunder, the stable phase being the normal form of dehydrothiotoluidine dealt with in the laboratory.



Consider the bromination of such a system. The bromination of the normal form will, of course, proceed by normal splitting of the double bond and brom addition to form the brom thiazole described in this paper. Consider next the bromination of the intermediate bridged phase. The bridge presumably will split with normal addition of bromine to the sulphur and nitrogen atoms and the formation of a thiazonium phase. The phenylated carbon atom, however, is unsaturated with a free valency, hence the bromine will wander from the sulphur to the carbon to form the normal form of brom thiazole with the conversion of the sulphur to the normal divalent state. This accounts for the non-ionisability of the brom thiazole as regards its added bromine. Lastly, consider the labile phase. Assume normal rupture of the double bond between sulphur and carbon. The nitrogen, however, is again more unsaturated, and the bromine atom wanders across the thiazole ring with the reassertion of the normal valency of the sulphur and the vanishing of a thiazonium phase. Therefore, the product is solely the normal addition product. This is borne out by experiment as no trace of an ionisable thiazonium compound can be detected in the solution of the brom thiazole in an ionising solvent.

It was thought to gain some insight into the relative stability of the brom thiazole ring by the study of the hydrolysis of one of the compounds with standard alkali. For this, it was necessary to obtain pure dehydrothiotoluidine dibromide. It was found that the bromination of dehydrothiotoluidine proceeds smoothly in ethyl alcohol, and further, yields a cleaner product than when the bromination is carried out in glacial acetic acid. Dehydrothiotoluidine was, therefore, dissolved in ethyl alcohol and brominated in the usual way, as described in the experimental portion, that is to say, by the careful addition of the necessary bromine from a burette. Now, the brom compound has always been regarded as insoluble in boiling ethyl alcohol by the author. In fact, in the series of papers on the preparation of these substances, it is recommended to reflux the brom compound with ethyl alcohol on a boiling water bath for an hour, to remove the last traces of impurity for careful work. With this object in view a fair quantity of the brom thiazole was placed in a flask fitted with a reflux condenser and heated on a boiling water bath for several hours. After some time it became clear that something unusual was happening, for the ethyl alcohol became brown, the product which was being purified became black, and brown crystals became deposited in the flask. The products were separated, washed and analysed. It was, of course, concluded that the crystalline compound was some form of product of alcoholysis, probably produced by the elimination of bromine from the tertiary nitrogen atom of the fused thiazole ring. The brom compound was found to be nothing more than a soluble modification of the brom thiazole compound, and the black insoluble form which is only converted after several hours' refluxing into the former, to be the same compound but a little less pure. The figures for bromine are a little lower.

Thus, this would appear to show that the brom compound can exist in two modifications, one soluble and one insoluble in alcohol, and the insoluble being capable of conversion into the soluble by continued refluxing with ethyl alcohol for several hours.

The method of hydrolysis was as follows: Weighed quantities of the brom thiazole were weighed into cleaned boiling tubes, 10 ccs. of standard alkali added, the mixture heated for a definite time in a boiling water bath at 100° C., the solution acidified with dilute nitric acid, excess silver nitrate run in from a burette, and the solution back titrated with standard thiocyanate with ferric indicator. It was thought that with time, the hydrolysis would increase till one bromine atom was eliminated, such that there would be a continuous curve or straight line if the time of hydrolysis was plotted against the volumes of standard silver nitrate; that is to say, plotting time against ccs. of silver nitrate, or bromine eli-

mination. A halt was expected after the elimination of one bromine atom, that is, the bromine atom attached to the strained nitrogen valency. Presumably there would then be hydrolysis of the second bromine atom and another elimination, producing another time volume curve, the end of which would become a straight line, parallel to the time axis proceeding to infinity. These results were by no means realised experimentaly. The curve rises a little, and then runs parallel to the time axis, but this does not by any means correspond to the elimination of one bromine atom, but something far below this. The alkali used was N/5, and should clearly have been strong enough to produce the necessary hydrolysis. The hydrolysis which does occur must be due to some impurity, or else the brom thiazole ring, on long boiling, must be assumed to isomerise to some more stable ring system under the action of the hot ethyl alcohol used in the purification. The acetyl dibrom has also been examined in a similar way with better results.

EXPERIMENTAL.

Dehydrothioparatoluidine (loc. cit.). Dehydrothiotoluidine Dibromide:

2 gms. of 4′ amino 1 phenyl 5 methylbenzothiazole are dissolved in the minimum of ethyl alcohol to form a saturated solution. The solution is brominated by adding excess of bromine from a burette with constant stirring. The brom solution is allowed to stand for twenty minutes, and the precipitate filtered off and washed with dilute alcohol and water, and then dried on the steam. The product is then refluxed for several hours with ethyl alcohol on a boiling water bath, and the brown crystals which separate on cooling filtered off and dried. This is used for the hydrolysis determinations.

Hydrolysis of the brom thiazole:

0.05 gm. of the benzothiazole is weighed into a clean boiling tube, previously washed carefully with distilled water, ethyl alcohol and ether. Four such amounts are weighed into tubes, the same weight being taken each time. An approximately 0.2 N. solution of sodium hydroxide is made up and standardised against standard sulphuric acid. Ten ccs. of this are pipetted into each of the tubes, and the tubes washed down with the same volume of distilled water. One of the tubes is then placed in a boiling water bath for five minutes, at the end of this time the water being boiled carefully to keep the temperature constant. The tube is withdrawn, the contents washed into a conical flask, and a slight excess of dilute nitric acid added immediately. Ten ccs. of standard N/10 silver nitrate are then run in from a burette, 5 ccs. of ferric indicator added, and the solution titrated back to a faint pink with N/10 ammonium thiocyanate. The experiment is then repeated for the other tubes for ten, twenty, and forty minutes, the silver nitrate and ammonium thiocyanate are run in from approximately the same range each time to eliminate errors for inequalities in the burette, avoiding the use of calibration curves, the end-point being taken from a previous standard neutralisation. The results as given hereunder, however, show that the hydrolysis does not proceed as was expected.

10 ccs. of silver nitrate equivalent to 8.7 ammonium thiocyanate.

5 minutes' hydrolysis, thiocyanate to neutralise			8.4 ccs.
10 minutes	,,	,,	7.9 ccs. (?)
20 minutes	,,	,,	8.1 ccs.
40 minutes	,,	,,	8.2 ccs.

Sulphuric acid, 0.56 N.

10 ccs. of sodium hydroxide equivalent to 3.3 ccs. H_2SO_4.

Wt. of brom thiazole = 0.050 gm.

The Imperial College of Science and Technology, South Kensington, S.W.7.
January, 1924.

PROCEEDINGS AND NOTICES OF SOCIETIES.

THE ROYAL SOCIETY.

THURSDAY, MARCH 6.

Papers read:—

E. D. ADRIAN, F.R.S., and SYBIL COOPER. *The Electric Response in Reflex Contractions of Spinal and Decerebrate Preparations.*

A. FLEMING. *A Comparison of the Activities of Antiseptics on Bacteria and on Leucocytes.* Communicated by Sir Almroth Wright, F.R.S.

Leucocytes which have been allowed to emigrate from a blood clot on to the walls of a capillary tube, or defibrinated blood containing its full quantum of leucocytes,

exercise a powerful bactericidal action on staphylococci.

When antiseptic solutions are brought into contact with such leucocytes or blood, it is found that the destructive action of the antiseptic on the leucocytes is much more marked than it is on the bacteria. When added to infected blood in certain concentrations, most of the antiseptics permit the development of almost all the bacteria implanted, although the blood without any antiseptic will destroy from 90 to 100 per cent. of the added cocci.

THURSDAY, MARCH 13.

Papers read:—

PROF. A. FOWLER, F.R.S. *The Series Spectrum of Ionised Carbon (CII).*

E. S. BIELER, PH.D. [Read by the communicator, Prof. Sir Ernest Rutherford, F.R.S.] *The Large Angle Scattering of α-Particles by Light Nuclei.*

PROF. W. L. BRAGG, F.R.S. *The Refractive Indices of Calcite and Aragonite.*

KATHLEEN YARDLEY. *The Crystalline Structure of Succinic Acid, Succinic Anhydride and Succinimide.* Communicated by Sir William Bragg, F.R.S.

L. F. BATES and J. S. ROGERS. *Particles of Long Range from Polonium.* Communicated by Prof. Sir Ernest Rutherford, F.R.S.

A. MULLER. *On the Determination of the Crystal-Axes in "Single-Crystal" Aluminium Bars by means of X-Rays.* Communicated by Prof. Sir Ernest Rutherord, F.R.S.

At the meeting of May 15, PROF. A. FOWLER, F.R.S., Yarrow Research Professor, will deliver the Bakerian Lecture on *The Spectra of Silicon at Successive Stages of Ionisation.*

THE ROYAL SOCIETY OF ARTS.

On Monday, March 10, the third Cantor lecture, entitled, *A Study of the Destructive Distillation of Coal*, was delivered by E. V. EVANS, F.I.C.

On Wednesday, March 12, at the Ordinary Meeting, a paper entitled *Personal Recollections of some Notable Scientific Men* was read by ALAN A. CAMPBELL SWINTON, F.R.S., late Chairman of the Council. The paper was illustrated by photographs. Sir Dugald Clerk, K.B.E., D.Sc., F.R.S., presided.

A Study of the Destructive Distillation of Coal. MR. E. V. EVANS, F.I.C., delivered the first of the three Cantor Lectures at the Royal Society of Arts on Feb. 25.

In the Cantor Lectures of 1919, Prof. Bone dealt with the general question of coal conservation, and Mr. Evans made a further contribution to this subject from the viewpoint of a chemist in the gas industry. He considered the destructive distillation of coal as a chemical process, the raw material entering being therms, while the process itself consists in the distribution of the original thermal energy of the coal into more useful and more economic forms.

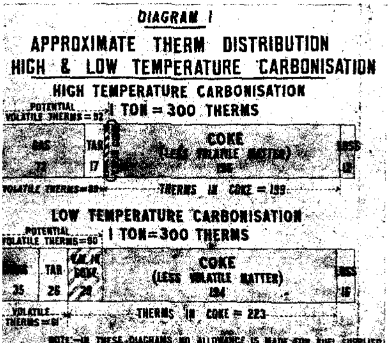
THE CONVERSION OF THERMAL ENERGY.

The introduction of the therm system had met with cold reception both by the public and the gas industry. This has given place to an acknowledgment of its value. The consumer and the industry benefit by the therm system.

The author's experience in the working-up of chemical bye-products has brought him into the closest working relationship with chemical industry. The chemical manufacturer approaches his task with a different outlook from the gas manufacturer, who does not always realise that he is operating a chemical process. Few large-scale reactions give a 100 per cent. yield of product, but a fierce struggle exists to attain the highest possible yield, as power to compete in the open market is largely determined by the efficiency of the process adopted. The amount of aniline made from unit weight of benzene, of beta-naphthol from naphthalene, of anthraquinone from anthracene, is measured and controlled with the greatest diligence. Chemical industry can flourish only if these principles of conservation and complete utilisation of bye-products are developed day by day. The gas engineer realises that his task differs only from that of the chemical manufacturer by the fact that he deals in therms and that his efficiency to compete depends upon his ability to market solid, liquid, and

gaseous therms in the most economical way. Each new development in our knowledge of the constitution of coal or its behaviour under heat—whether it be made at the University of Leeds, or at the Imperial College of Science, or under the Fuel Research Board, or in the gas industry itself—brings the process of coal distillation nearer to a true chemical process.

Our major duty in the gas industry is to make gas, but this responsibility should not cause us to overlook the fact that it is possible to distribute the therms of the original coal into gas, tar, and coke in a variety of ways. The method of distribution is determined by the nature of the process adopted and the conditions of operation. It is proposed to analyse the principles of carbonisation. In the interests of our main product (gas) attention must be paid to subsidiary products. These are sources of therms, to be placed in a position only just second to that of gas. The word "residual" should entirely disappear from our industrial vocabulary and be replaced by "bye-product."



NOTE.—IN THESE DIAGRAMS NO ALLOWANCE IS MADE FOR FUEL SUPPLIED EXTERNALLY TO THE RETORT FOR EFFECTING CARBONISATION.

Fig. 1.

Diagram I. indicates the general distribution of therms when coal is subjected to the high and the low temperature carbonisation.

In the case of high-temperature distillation, 1 ton of coal containing 300 therms will yield about 72 therms of gas of 560 B.Th.U. per cubic ft. and 17 therms of tar, leaving coke containing about 199 therms. The process loss will be about 12 therms. The loss in low-temperature carbonisation is about 16 therms. The loss of therms from the original coal substance is due to the fact that the heat required for distillation is not taken wholly through the walls of the retort, but is partly supplied from the coal undergoing carbonisation. The low-temperature carbonisation of 1 ton of coal yields some 35 therms of gas of 1090 B.Th.U. per cubic ft. (3200 cubic ft.), 26 therms as low-temperature tar, and 223 therms of coke itself containing 9.3 per cent. of volatile matter. Determinations made upon low-temperature fuel containing about 10 per cent. volatile matter have shown that the 9.3 per cent. of volatile matter remaining in the coke would represent about 29 therms of the potential volatile matter of the original coal. Now if this potential volatile matter be added to the amount actually obtained, there is practically no difference in the yield of so-called volatile therms and coke therms in the two methods. There is a difference in favour of low-temperature carbonisation represented by the slightly lower fuel consumption required for the process of distillation, but the bye-products, gas and tar, and even the solid fuel itself, must not be utilised for this purpose.

This analysis of the low-temperature process has been introduced partly for the purpose of demonstrating that the destructive distillation process should be viewed as a means of distributing the energy of the original coal into therms of different value, and partly with the object of proving the value of the therm interpretation in carbonisation, and finally to prepare the way for demonstrating that the form in which the volatile therms are distributed, is controllable and may be altered or adjusted by the method of distillation adopted.

The author has found that a convenient method of examining the amount of useful work effected during each hour of the carbonising period is to produce a thermal the hourly volume curve and calorific value model. The value of this means of representation is, first, that the mass of the model itself is proportional to the thermal yield of gas from the coal, and, secondly,

that a section taken at any one period shows in its area the amount of work being done at that instant.

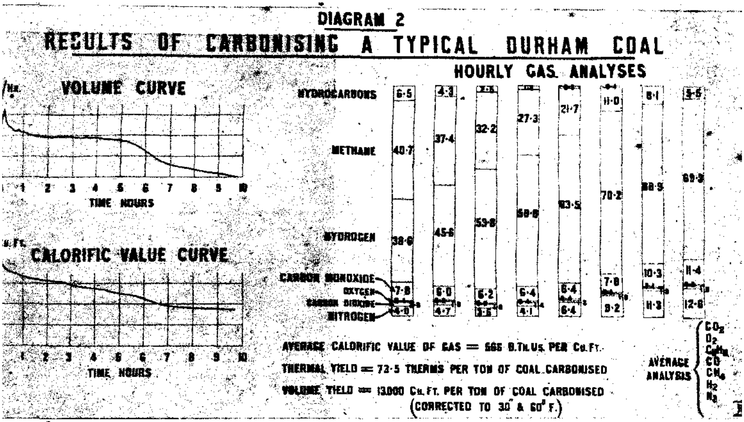


Fig. 2.

SHOWING THERMAL YIELD DURING MIDDLE 10 MINUTES OF FIRST AND LAST HOUR OF CARBONIZING PERIOD.

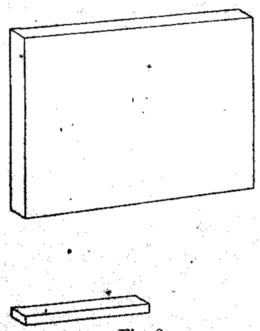


Fig. 3.

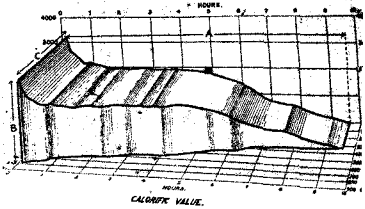


Fig. 4.

Fig. 3 shows sections of the thermal model (Fig. 4), taken from the middle ten minute period of the first and last hours of

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The thermal models constituted a device for detecting any slight differences in the carbonising process, or for determining the effect of any adjustments of the conditions of working. For obtaining a high thermal yield it has been found necessary to reduce the vacuum in the hydraulic main of any one section to level gauge when some of the retort doors of that section are open for charging or discharging. As hourly charging is adopted, it is thus the practice to reduce

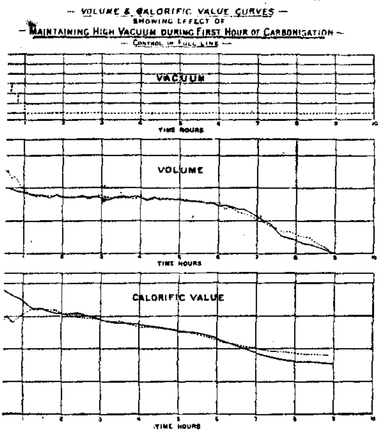

Fig. 5.

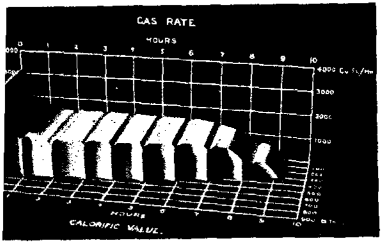

Fig. 6.

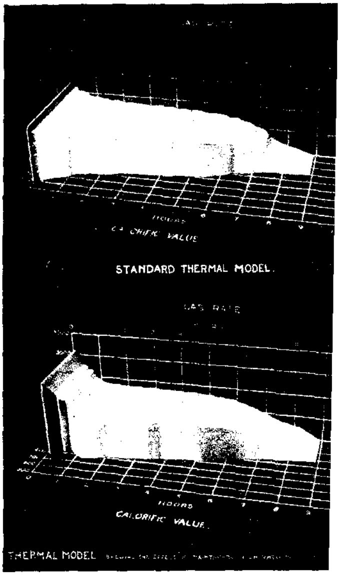

Fig. 7.

hour. An examination of the thermal models will show that at these periods there is a definite indent in the volume curve, and that immediately following this, when the vacuum is re-established, there is a corresponding peak in the calorific value curve. It is evident, therefore, that gas has been throttled-up during this period level gauge. Generally speaking, t method of procedure does not materi affect the thermal yield of gas, provided retorts are tight. This practice is dis trous in the case of unsound retorts.

(*To be continued.*)

THE ROYAL INSTITUTION.

A General Meeting of the members of the Royal Institution was held on March 3, Sir James Crichton-Browne, Treasurer and Vice-President, in the chair. The special thanks of the members were returned to Major C. E. S. Phillips for his donation of £50 to the research fund, and to Mr. T. B. Gilley for a present of radioactive minerals from Cornwall.

Miss S. G. Allport, Mr. F. H. Berryman, Dr. W. R. Bisschop, Lady Bragg, Lord Chelmsford, Col. R. H. Elliot, Sir David Ferrier, Mr. F. M. Geoghegan, Miss E. N. Gibbs, Mr. S. J. Gunningham, Mr. C. H. Harrison, Sir Joseph Isherwood, Sir Herbert Jackson, Sir Lawrence Jones, Mrs. Pethick Lawrence, Mr. J. Layzell, Mr. C. H. Merz, Mrs. W. D. Patterson, Lady Muriel Percy, Mr. G. P. Pollitt, Mr. C. Y. Royds, Mr. B. P. Scattergood, Dr. D. H. Scott, Mr. P. F. Tuckett, Mr. T. V. Smith, Mr. C. H. Watkins, Mr. W. T. Watson and Dr. C. H. Weiss were elected members.

SOCIETY OF PUBLIC ANALYSTS AND OTHER ANALYTICAL CHEMISTS.

ORDINARY MEETING, WEDNESDAY, MARCH 5.

Mr. G. Rudd Thompson (President) in the chair.

The following were elected members of the Society:—

Messrs. Hugh Browning Brown, A.I.C.; Sidney Augustus de Lacy, A.I.C., A.M.I.-Ch.E.; Joseph Henry Lane, F.I.C., B.Sc. (Lond.); Leslie Herbert Lampitt, D.Sc. (Birm.), F.I.C.; Reginald Francis Moon, B.Sc. (Bristol); Maximilian Nierenstein, D.Sc. (Geneva), Ph.D. (Berne); William Simpson Shaw, M.Sc., A.I.C.; Robert Norman Wright, A.R.C.S., B.Sc. (Lond.), A.I.C.; Misses Phyllis Honor Price, B.Sc. (Bristol), and Mabel Susanne Lavinia Snelus, A.I.C., M.P.S.

The following papers were read:—

The Composition of Beef and Malt Wine, by G. D. ELSDON, B.Sc., F.I.C.

The author described a recent case of adulteration of beef and malt wine in which a conviction was obtained. He gave the composition of various extracts of beef and malt, including those taken from previously published works, and those obtained under ordinary commercial conditions and examined by himself. A number of analyses of wine likely to be used in the preparation of beef and malt wines were also given, and from the analyses a standard was suggested which all commercial samples of such tonic wines should reach. Finally, fairly complete analyses of a number of commercial tonic wines were quoted.

Effect of Fatty Diet on the Composition of Butter Fat, by J. C. DRUMMOND, D.Sc., F.I.C., and H. J. CHANNON, B.A., B.Sc.

Cows were given, as a supplement to a fixed basal ration of a very low fat content, coconut, arachis and cod liver oils in amounts varying from 2 to 8 ozs. per day for periods up to 35 days. At intervals samples of butter fat from the milk of individual cows were examined as regards Reichert-Wollney, Saponification and Iodine Values, Refractive Index and Vitamin A. content. Curves showing the rise and fall in these values show marked similarity in the different cows, and would appear to indicate definite passage of the oils to the butter. The percentage and total fat showed a distinct fall during the cod liver oil feeding, but whether this is due to a specific effect of the oil or to the advancement of the period of lactation, is uncertain. The vitamin A. value rose markedly during this period. Attempts to make a quantitative study of the effect of the oil feeding on the composition of the butter fat, by fractional distillation of the methyl esters of the fatty acids, failed. The technical difficulties of fractionating esters of a series of acids so closely related, appears too great for the method to be of any use in quantitative work. The majority of recorded analyses of butter fat, particularly those in which the percentage of each fatty acid is given to one or more places of decimals, are regarded as of doubtful value.

What is Bondon Cheese? by G. D. ELSDON, B.Sc., F.I.C.

The evidence from public analysts, agricultural colleges and the dairy industry with regard to the composition of Bondon cheese was reviewed. The opinion was stated that a Bondon cheese should be a whole milk cheese, and should therefore contain at least 20 per cent. of fat. Objection was taken to the pleading of "Trade Custom" in prosecutions under the Sale of Food and Drugs Act, merely because pos-

sible adulteration has been carried on unchecked for a number of years.

Cream Cheese, by T. R. HODGSON, M.A., F.I.C.

The standard of 20 per cent. of fat in cream cheese, proposed to be set up in the recent legal proceedings instituted by the Holborn Borough Council, was objected to because it does not take into account the composition of the original milk, from which the cream cheese was made; the suggestion was made that in any similar prosecution, the vendor should be charged with selling cream cheese made from a milk partially deprived of its fat, any appeal from such an information would have to be taken to the High Court of Justice instead of to the Quarter Sessions, and the decision of the High Court would, of course, be binding on the whole country, whereas the decision of the London Quarter Sessions is binding on London only.

Some Facts on the Composition and Decomposition of Eggs, by R. J. THOMSON, F.I.C., and JAMES SORLEY, F.I.C.

Contrary to Jean's statement, the fat can be completely extracted from dried egg yolk by any of the three solvents—petroleum spirit, ether, or chloroform. A small proportion of any boric acid present is simultaneously extracted by petroleum spirit or ether. Repeated extraction with ether, in a separator, of yolk diluted with water, removes all the fat, but petroleum spirit extracts only a small fraction of it. The yolk of a recently laid hen's egg contained 0.59 per cent. of free fatty acid (1.72 per cent. of the fat), and 4.28 per cent. of unsaponifiable matter. It was shown that extraction with petroleum spirit removes only a small percentage of the unsaponifiable matter from the yolk. The constants of the fat from the yolks of hens' and ducks' eggs and from preserved Chinese hens' egg yolks were given, the last being characterised by high acid values. Decomposition of egg yolk is accompanied by a gradual rise in the acid value of the fat.

THE OPTICAL SOCIETY.

A meeting was held at the Imperial College, Imperial Institute Road, South Kensington, on March 13.

Demonstrations in the laboratories of the Optical Engineering Department included the apparatus and methods described in the papers below, and in addition the following were shown:—

Demonstration of optical aberrations by Messrs. Cooke, Troughton & Simms' "Pathological" set of object glasses.

Lens testing bench designed for large "air photography" photographic lenses.

Hartmann test applied to microscope objectives.

Foco-collimators and various focometers.

Projection of rock-sections in polarised light, and other polarisation experiments.

Experiments in diffraction, interference, etc., with some practical applications.

Sundry other experiments in photometry, refractometry, polarimetry, etc.

Amongst the exhibits and demonstrations in the Instrument Design Laboratory (Professor Pollard) were:—

Experimental models of nephelometers.

Accessory for squaring-on and centring micro-objectives.

The illusion of relief in low powered microscopy by means of a rotating eccentric diaphragm.

The Cambridge one ton single lever testing machine and the determination of Young's Modulus.

Improved Ewing's apparatus for experiments on the bending of bars.

Wooden models of the generalised mechanism of Sarrut.

The geometrically designed microscope of Keith Lucas.

Experimental model of a sensitive gas balance.

Wood's method of preparing reflecting Collodion films.

The remarkable crystals of the sulphate of iodo-quinine discovered by Dr. Herapath in 1851.

The decimal classification of knowledge by the Institut International de Bibliographie and its application to the indexing of the papers contained in the Transactions of the Optical Society, now in progress.

The following papers were presented and discussed:—

A Study of the Significance of the Foucault Knife-edge Test when applied to Refracting Systems, by MISS H. G. CONRADY, A.R.C.S.

A Reflecting Spherometer, by B. K. JOHNSON.

Note on a convenient Bench for Testing Telescopic Object Glasses, by L. C. MARTIN, D.Sc., A.R.C.S., F.R.A.S

The Measurement of Chromatic Aberration on the Hilger Lens Testing Interferometer, by R. KINGSLAKE and L. C. MARTIN, D.Sc.

THE INSTITUTE OF CHEMISTRY OF GREAT BRITAIN AND IRELAND.

At the 46th Annual General Meeting of the Institute of Chemistry, held at Russell Square on March 3, the Meldola Medal, the gift of the Maccabaeans, was presented to Mr. C. N. Hinshelwood, B.A. (Oxon.). The medal is awarded for the work of most promise published by a British chemist under thirty years of age, brought to the notice of the adjudicators during the year.

Mr. A. Chaston Chapman, F.R.S., the retiring President, in his address, referred to the growing activity of the Institute during his three years of office. The roll of membership had increased by 1129, and about 1,000 new chemists had been absorbed into useful professional life. He emphasised that the Institute endeavoured to counteract the modern tendency to turn out narrow and imperfectly educated specialists. He deplored the tendency on the part of Government Departments to under-value professional, scientific and technical service, especially in view of the fact that the public chemical service is becoming every year a more important part of the machinery of government.

Dealing with the proposals for closer co-operation amongst chemical societies, which he thought should have the warm support of all, he expressed the hope that in any scheme of co-operation the Institute would not sink any of its individuality. The general public was coming more and more to recognise in chemistry one of the most powerful factors in the creation of material wealth, at a time when it is more important to create wealth than to quarrel about the distribution of what little the war had left us. He quoted Mr. Baldwin, the late Prime Minister, who, in a recent speech at Glasgow, had said that under the stimulus of the war we had made great headway in pure chemistry, and we had schools of chemistry in this country which compared with any in the world. We should take care that our industries absorbed the output of those schools, and should not be content to run only rule-of-thumb industries and leave those more highly organised industries, which depend upon science and brain power, to the foreigner. He felt that those words had a very special significance with reference to the reported negotiations between the British Dyestuffs Corporation and the Interessen Gemeinschaft.

The new President, Prof. G. G. Henderson, F.R.S., Regius Professor of Chemistry in the University of Glasgow, was formally installed.

The officers, Council and censors for 1924-25 were elected as follows:—

Vice-Presidents: Prof. E. C. C. Baly, C.B.E., F.R.S.; Messrs. A. Chaston Chapman, F.R.S.; Andrew More; Dr. T. Slater Price, O.B.E.; Prof. Arthur Smithells, C.M.G., F.R.S.; and Mr. E. W. Voelcker.

Hon. Treasurer: Mr. Patrick H. Kirkaldy.

General Members of Council: Mr. Leonard Archbutt; Dr. E. F. Armstrong, F.R.S.; Mr. E. R. Bolton; Prof. A. A. Boon; Dr. F. D. Chattaway, F.R.S.; Mr. R. Leslie Collett; Dr. G. Colman; Mr. John Evans; Dr. R. H. Greaves; Prof. A. J. Hale; Mr. G. Nevill Huntly; Prof. W. H. Lewis; Mr. W. McD. Mackey; Dr. H. McCombie, D.S.O.; Dr. R. S. Morrell; Mr. G. H. Perry, O.B.E.; Prof. J. C. Philip, O.B.E., F.R.S.; Dr. R. H. Pickard, F.R.S.; Mr. B. D. Porritt; Prof. F. L. Pyman; Mr. W. D. Rogers; Mr. H. Silvester; Dr. Arthur Slator; Prof. J. F. Thorpe, C.B.E., F.R.S.; Dr. J. F. Tocher; Dr. D. F. Twiss; Prof. F. J. Wilson.

District Members of Council: Dr. Leonard Dobbin (Edinburgh and East of Scotland), Mr. H. J. Evans (Liverpool and North-West Coast), Dr. W. R. Fearon (Irish Free State), Dr. W. H. Gibson, O.B.E. (Northern Ireland), Mr. C. A. F. Hastilow (Birmingham and Midlands), Mr. E. M. Hawkins (London and South-Eastern Counties), Mr. R. D. Littlefield (Bristol and South-Western Counties), Mr. S. E. Melling (Manchester and District), Dr. L. G. Paul (North-East Coast and Yorkshire), Mr. C. A. Seyler (Wales and the County of Monmouthshire), and Mr. J. H. Young (Glasgow and West of Scotland).

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THE INSTITUTION OF PETROLEUM TECHNOLOGISTS.

The Eleventh Annual General Meeting was held on Tuesday, March 11, when the President, HERBERT BARRINGER, M.I.-MECH.E., M.I.N.A., M.INST.MAR.ENG., gave an address.

THE CHEMICAL SOCIETY.

Papers read at the Ordinary Scientific Meeting, March 6:—

The Reaction between Lime and Nitrogen Peroxide, by J. R. PARTINGTON and F. A. WILLIAMS.

The products of reaction between pure nitrogen dioxide and lime are calcium nitrite, calcium nitrate, nitric oxide and nitrogen. The proportion of calcium nitrate in the product is more than equivalent to the calcium nitrite. The loss of nitrogen as elementary gas varies, the maximum being about 5 per cent. The existence of the hydrate of calcium nitrite, $Ca(NO_2)_2 . 4H_2O$ has been confirmed. The thermal decomposition of calcium nitrite has been found to commence at 230°, the products below 480° being calcium nitrate, calcium oxide, nitric oxide and nitrogen. Above 480°, nitrogen dioxide is also obtained. Calcium nitrite is readily oxidised to calcium nitrate by nitrogen dioxide, which is reduced to nitric oxide and nitrogen. The nitrogen set free during the reaction of nitrogen dioxide and lime is due to this reduction. Calcium nitrite, when heated in oxygen below its decomposition point, was found to remain unoxidised, but on admitting nitrogen dioxide oxidation occurred, the dioxide being alternately reduced to nitric oxide and reproduced from this by oxidation with free oxygen.

Tellurium Monoxide, by J. J. DOOLAN and J. R. PARTINGTON.

The experiments of Divers and Shimosé on the production of tellurium monoxide by heating tellurium sulphoxide, $STeO_3$, in a vacuum at 180°, were repeated and confirmed. The product had the properties described by Divers and Shimosé, and the results obtained by Weber are therefore incorrect.

The Isomerism of the Oximes. Part XVII. The action of 2:4-dinitrochlorobenzene on some Isomeric Aldoximes, by O. L. BRADY and R. TRUSZKOWSKI.

Dinitrochlorobenzene reacts with the sodium salts of substituted benz*anti*aldoximes to give dinitro-phenyl-ethers, which have the *syn*-configuration since they are decomposed, on being warmed for a short time with alcoholic sodium hydroxide, with the formation of sodium dinitrophenate and the corresponding nitrile. *o*-Hydroxybenz*anti*aldoxime does not react in this way, and in a few other cases the yield of ether is small. With the sodium salts of *syn*-aldoximes a complicated reaction occurs, but from the products only sodium dinitrophenate and the corresponding aldehyde could be isolated. The binary fusion curves of the *anti*-oximes and dinitrochlorobenzene indicate that in certain cases well defined addition compounds are formed, consisting of equimolecular amounts of the two components. That stable addition compounds with dinitrochlorobenzene were characteristic of those oximes which could readily be converted into syn-isomerides seems to support the view that the formation of addition compounds is at the base of isomeric change in the oximes.

The Dimorphism of Diphenylarsenious Chloride (Diphenylchloroarsine), by C. S. GIBSON and (the late) D. C. VINING.

The dimorphism of diphenylarsenious chloride, which has not been previously recorded has been definitely established. The unstable form, which melts at 18.2-18.4°, forms colourless, silky needles. The stable form, m.p. 38.7-38.9°, forms rhomb-shaped biaxial doubly refracting crystals. Both forms have a normal molecular weight in benzene solution. The boiling point of pure diphenylarsenious chloride is 178.6°/10 mm.

THE SOCIETY OF GLASS TECHNOLOGY.

At the meeting held in Sheffield on Feb. 20, there was an exhibition and demonstration of modern pyrometers at the Department of Glass Technology of the University. The following firms exhibited:—

The Bowen Instrument Co., Ltd.; the Cambridge & Paul Instrument Co., Ltd.; the Foster Instrument Co.; the Optical Pyrometer Syndicate; Messrs. Booth & Miller also demonstrated their new temperature controller.

There was also a discussion on "The Use of Pyrometers in Glass Works." Five papers were presented as follows:—

The Use of Pyrometers in Glass Works, by E. A. COAD-PRYOR, B.A.

The value of pyrometric equipment in a glass factory depended essentially on three factors: the reliability of the pyrometer itself, particularly the clock-work; the skill which is expended on its maintenance; and the attitude with which the management, foremen and furnace operators regard the pyrometer.

Of these three the last was regarded as the most important. The pyrometer in no way displaced the trained eye; its real function was to supply further information in order that a highly skilled operator might be able to get more out of his plant than had hitherto been possible.

The range of temperatures to be measured could conveniently be sub-divided into the range 0° to 700° C., covering lehrs, stack temperature, producer gas, etc.; from 700° to 1200° C., regenerator temperature, pot work; and above 1200° C., the temperature of the melting furnaces.

In the first group the thermo-couple was the most convenient instrument to use. Some sort of a portable thermo-couple should be part of every works' equipment. A convenient couple for low temperature work was iron-constantan, the wire to be about 22 gauge.

In the high temperature ranges an optical or total radiation pyrometer was, as a rule, the most convenient. The tank furnace might be sub-divided into three zones; the melting zone, the plaining zone, and the refining end. Two permanent pyrometers should be used on each furnace, one on the refining end, the other sighting through a hole in the end wall at the melting end of the furnace. The use of couples embedded in the wall of the tank or in the crown caused probably more trouble than they were worth.

The optical or radiation pyrometer, if used with discretion, was the most reliable and the most easily applied. The author's experience was that the optical instruments gave less variable readings than did the radiation instruments. The all important factor with any installation was the training of the staff and operators to use the instruments with intelligence as an aid to the maximum efficiency in furnace manipulation. A bibliography was added to the paper.

(*To be continued.*)

New Patents.

THIS list is specially compiled for *The Chemical News* by Messrs. Rayner & Co., Registered Patent Agents, of 5, Chancery Lane, London, from whom all information relating to Patents, Trade Marks, and Designs can be obtained gratuitously.

Latest Patent Applications.

4397—Chemical Engineering and Wilton's Patent Furnace Co., Ltd.—Manufacture of sulphate of ammonia. Feb. 20.

4173—Hereward, H. W.—Production of hydroxyanthraquinones. Feb. 18.

4190—Leyser, F.—Extraction of roasted zinciferous ores, etc. Feb. 18.

Specifications Published this Week.

210824—Hennes, C.—Preparation of ores for leaching process.

210890—Soc. of Chemical Industry in Basle.—Manufacture of azo dyestuffs and chromium compounds thereof.

204722—Farbwerke vorm. Meister, Lucius and Bruning. — Manufacture of diamino-diaryldkylmethanes.

Abstract Published this Week.

209350—Arsenious sulphide and oxide; sulphur dioxide; sulphuric acid.—Jordan, L. A.; The Chestnuts, Brantham, Suffolk.

Arsenious sulphide and oxide; sodium and calcium thioarsenates; sulphur dioxide; sulphuric acid.—Arsenious sulphide is separated from arsenious sulphide mud, for instance, the mud obtained in the treatment of sulphuric acid with sulphuretted hydrogen, the sulphuric acid being recovered also, by mixing it with a small quantity of an organic substance such as benzene, petrol, mineral oil such as paraffin oil, toluene, cresols, tar oils, turpentine, chloroform, and carbon disulphide. Other compounds, such as amyl acetate, nitrobenzene, sulphonated oils, sperm oil, soap solution, fatty acids, linseed oil and paraffin wax may be used alone or in admixture or in solution in the lighter solvent oils, but are not usually so advantageous, and certain other organic compounds such as aniline or pyridine are suitable when the liquid associated with the arsenious sulphide is not acid, but are not suitable when it is acid. The separation may be facilitated by warming or agitation, and the sulphide is then separated by ordinary means, such as filtration, centrifugal action or settling. The sulphide thus obtained is associated with the organic substance employed, but may be washed practically free of the liquid originally associated with it. The organic substance may be recovered by the use of a vacuum drier or by dissolving the sulphide in a solvent such as sodium hydrate, sulphide, or polysulphide, to obtain sodium or calcium thioarsenate; or the organic substance may be left to facilitate the burning of the sulphide when it is desired to make arsenious acid and sulphur dioxide, the latter being then used for the production of sulphuric acid.

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THE CHEMICAL NEWS,

VOL. CXXVIII. No. 3336.

FINE GLASS MANUFACTURE.*

By J. H. GARDINER, F.INST.P., F.C.S.

In connecting the word "fine" with glass manufacture, I do not propose to confine myself to the Art side of the subject, for although good glass is most certainly a thing of beauty, and there is much in a skilfully formed piece of glassware that appeals to the imagination and taste, there is also bound up in the science of glass production much that calls for the highest refinement of skill and precision on the part of the producer.

I propose, therefore, as far as time will allow me, to deal with the subject in the broadest possible sense.

Glass has been known from very early times—the manufacture was practised by the Egyptians many centuries B.C. Coloured beads have been found recently by excavators on the sites of the ancient cities of Babylonia associated with remains of very early date indeed, and the Art had reached a high stage of development in the days of Imperial Rome, when that nation was at the height of its glory.

The fragile nature of glassware has made very early specimens a rarity, although a few fine examples are to be found in our museums. I have two specimens that I value very highly, one a Grecian "Tear Bottle," given to me by Mr. Alexander Ionides, who fixes the date not later than the second century A.D., and the other a handled bottle of early Roman workmanship of about the same date.

In both cases age has brought about a very beautiful iridescence, due to decomposition of the surface.

As this effect of the slow decomposition of glass surfaces is not only of considerable interest, but of great practical importance, I would like to devote a few minutes to its consideration.

GLASS.

The combination of silica with an alkali or metallic oxide may be regarded either as a simple melted mixture of various ingredients not very closely bound together, or by careful adjustment of the known reactions of its components it may approach closely to the nature of a true chemical compound.

Speaking broadly, the more intelligent the selection of its components, the method, temperature, and other details of the "founding," the more stable will be the resulting product, and conversely, ignorance and carelessness in the preparation of the "batch" (as the raw material is called) and its subsequent heat treatment may result in a glass that will quickly disintegrate, even with atmospheric influences alone.

All the stages between these two extremes are to be found in modern glasses, and as there is still a great deal of the old "rule of thumb" method practised in some of our British glass houses, the matter is extremely serious.

The fact that we have examples of ancient glass that have existed for many thousands of years (and some of the Babylonian beads to which I have referred are said to be as bright and clear as when they were produced) does not in itself suggest that any great chemical knowledge of the subject was possessed by the old craftsmen, as anything unstable would disintegrate and leave no record, the examples that we have may be simply cases of the survival of the fittest, but they are very interesting as showing the effect of long continued action of gases and vapours upon fairly stable silicates.

A microscopic examination of decomposed glass surfaces, such as that of the Greek tear bottle, shows that the colour effect is due chiefly to the formation of a mass of small blisters such as would be produced in a crude way by scorching a painted surface, each little blister giving a play of colour due to refraction of light, exactly as does a soap bubble. There are other surface effects due to the same cause, some examples of which are shown under the microscopes.

Another interesting example of chemical action on a highly complex glass is furnished by a fragment of a fourth century coloured window glass, given to me by Mr. Harry Powell. The body of this glass is pale green and it has been flashed at the back with ruby and on the front with a thin coat of blue, in which probably nickel cobalt copper and other metallic oxides have been used. Some photomicrographs show remarkable diffusion effects, and the actual

* *A lecture delivered before the Chemical Association of the Northern Polytechnic, London, on March 11, 1924.*

specimen on the table is an exceedingly beautiful object, the appearance of which is similar to the so-called "Liesegang" figures, showing a series of bright metallic rings radiating from central neuclei, suggesting, as in the case of the blisters already referred to, that surface condensation has resulted in a solution of the constituents in a colloidal form, from which they have been deposited in rings, as in the case of some agates where iron and other salts have penetrated into a gel of silicic acid.

I put this forward merely as a suggestion. Possibly other explanations could be found.

Glass Founding.

A modern furnace usually holds ten or more pots. These are made from the finest fireclay, and hold about fifteen hundredweights of glass. They are first brought to a temperature of about 1200° C., and the dry batch is filled in, the fronts closed, and the temperature raised to about 1400° C. and kept so for about 36 to 40 hours.

Science, which has been well termed "organised common sense," has largely replaced many of the old empirical procedure and traditions of the glasshouse. Given a proven formula for a glass of a particular character, it is only necessary to keep a proper check on the quality and condition of the materials—see that they are correctly weighed and mixed, and after filling the batch into the pots, that a predetermined degree of heat is applied for a given time—and the result is certain.

Heat treatment has been made easy by the modern furnace, which enables it to be regulated and maintained with ease, and when reliable pyrometers are in use it is only necessary to give instructions that the temperature shall be raised to a certain point during a given time, and that this temperature shall be maintained for a given period which varies according to the nature of the glass. A glance at the "chart" enables the manager to see how closely his instructions have been carried out, and from the known amount of heat that has been put into the glass he can decide with tolerable certainty how long the melting temperature shall be continued to complete the process, after which the temperature is slowly lowered to the working degree—about 1100° C.

Artistic Productions in Glass.

Given a glass of pure and well proportioned constituents, a material is at hand eminently capable of very artistic treatment. The delicate touch of the craftsman may be preserved as a thing of beauty for generations.

Certainly something of that character is preserved in the little Greek tear bottle. It is a simple enough object, and yet there is a gracefulness in the proportions and curves that instantly carries one's mind back those seventeen hundred years, and sets one wondering what that old craftsman was like, who he was, and what were his surroundings. These questions cannot be answered, but the fact remains that dead and forgotten though the man may be, there was a certain something in his mind conveyed through his hands to that little object on the day that he made it that will remain with it as long as it lasts.

"A thing of beauty is a joy for ever."

As is well known, glass making attained, and still holds, a very high position in Venice, and some wonderful pieces of workmanship have been produced by Venetian craftsmen. Some of them, to my mind, are more wonderful than beautiful. Such, for instance, as the twisted and decorated cup poised upon the tail of a glittering serpent. It is a wonderful production, and that is all one likes to say about it.

I have here a few specimens of modern glassware that show the truly artistic treatment that is possible, even in such common place articles as decanters and wine glasses. Most of these specimens are by the craftsmen of the Whitefriars Glassworks, and are lent by Messrs. James Powell & Sons (Whitefriars), Ltd.

Need for the Chemist in Glass Making.

The articles before you are mostly examples of flint glass, a lead-potash silicate of great density and high refractive index. The preparation of glass of this quality needs the greatest care and incessant attention from its "founding" until it is safely out of the annealing lehr, and, in fact, until it is in the hands of the customer—after that it does not much matter. The materials used in its preparation must be of the purest quality attainable, and must be constantly checked by both chemical and physical examinations. The sand used is almost invariably brought from Fontainebleau, near Paris, where huge deposits of exceedingly pure silica are available. The iron content of such a sand is about 0.03 per cent. The lead, potash and other materials must be very pure, and need constant ex-

-amination, but even then an exceedingly small trace of metallic impurity (chiefly iron), either from the materials or from the pots and crucibles in which they are melted, would result in a glass with a more or less dingy or greenish tint that is often seen in early or cheap glassware, and here the skill of the chemist comes into play. The faint pink colouration that results from almost homeopathic addition of manganese selenium and other so-called decolourisers, is made use of to neutralise the green colour due to iron, and the combination, if correctly balanced, results in a very clear crystal glass. The greatest judgment is necessary in the use of these decolourisers, because while a deficiency fails to give the desired effect, a slight excess produces a most unpleasant pink tinge, and as the final result is largely dependent upon the heat treatment during "founding" and the length of time that elapses between the moment that the metal is fine or ready for working and when it has left the hands of the workman, the lot of the responsible works chemist is an anxious one.

There is a curious effect produced by the action of light upon glass that contains manganese that is interesting. It has doubtless been noticed by many here that some old window panes that have been exposed to sunlight for many years have turned pink from this cause. I have here some specimens of broken glasses and decanters that have been exposed to intense sunshine for long periods, and although they were probably quite colourless when made, they have turned a deep, beautiful amethyst. Other similar colourations are brought about in glass by the action of X-rays or radium, of which some specimens are on the table.

Together with many industries, glass makers learned a great deal when the war was upon us, and although many praiseworthy resolutions were made that never again should the country find itself dependent upon outside sources for such vital necessities as glass apparatus for its chemical, medical, and physical professions, I fear, alas, that like many other lessons that were forced upon us, they are rapidly being forgotten. But I must not wander into politics. . . . The manufacture of glassware for industrial and scientific purposes calls for very high skill and knowledge on the part of the producer if England is to hold her own in this important field of work.

Glass for the chemical laboratories must not be greatly effected by changes of temperature. It must be resistant to the action of boiling water, to acids and alkaline solutions, and of such a nature that it can be readily formed into vessels. The demands of the medical and bacteriological profession are of ever-increasing refinement. The greatly extending use of serums, vaccines and colloidal preparations calls for glass containers of such a quality that no action at all shall be produced in the most unstable compound that it is desired to hold. The photographic profession needs glasses with special actinic properties. Electricians call for material with high or low dielectric properties for their particular needs, while the meteorological and clinical world demands a glass that shall possess great thermal endurance (resistance to deformation after long continued rapid changes of temperature), and with an exactitude of dimensions that at first would seem well nigh impossible.

As this last reference is to a production to which I have devoted a good deal of time, I propose to explain the process in detail, for it is a case of what may be safely called *fine* glass manufacture.

THE MANUFACTURE OF THERMOMETER TUBING.

The production of clinical thermometers is a matter of great importance and of considerable magnitude. The importance of the instrument is probably known to most here. In these days of intermittent colds and influenza to "have a temperature" means stopping work and all other activities and to stay in bed, with all its attendant horrors, until the clinical registers "normal" again.

The glass tube used for the instrument is not round in section, but roughly, triangular, or, as it is called "lens fronted" (incidentally I may say that in my young days I knew the man who invented this form of tube, and if time permitted could tell you an interesting story about it).

The curved edge at the top forms a lens that magnifies the bore which holds the mercury, making the column stand out like a broad band, although it is in reality as fine as a hair. Now it is absolutely essential, for reasons that I need not enter into, that the area of that bore shall only vary within very small limits. It must not measure across its longest diameter more than 0.400 m/m or less than 0.200 m/m, and across its narrow diameter more than 0.15 or less than

0.090 m/m, or it is useless for the purpose, and the task of the workman is to produce a tube that shall be externally correct as regards the "lens," the "enamel," the "diameter," and at the same time shall have a bore falling within these small limits. As no machinery whatever is used the result depends entirely upon the skill and judgment of the craftsman.

I will describe briefly, but in detail, the stages leading to its production. The workman gathers upon the end of his blowing iron a lump of glass from the pot of molten metal at his side, and by blowing down the hollow iron makes an air chamber forming a thick walled bubble. At this stage a flat slab of white enamel glass is attached to one side, and the whole is well melted together; now comes a very pretty knack that takes more time to describe than to perform. A rapid twirl is given to the iron, and by centrifugal force the ball is converted into a rough cylinder, the air bubble becoming tubular in shape. Now, with a tool like a butter pat, the cylinder is flattened into an oval, the air chamber, of course, taking the same shape. After cooling for a few moments to allow the glass to become set, it is again dipped into the molten metal, and on withdrawing, the ball is coated with a thick coating of clear glass. It is now rolled on a polished steel plate called a marver, to make it quite cylindrical, and then the triangular shape is given to it by allowing it to rest for a moment in a V shaped carbon block. It is now ready for the final operation. A fellow workman who has prepared another iron with a knob of hot glass at one end, comes forward and dexterously attaches his iron to the other end of the glass lump, and then the men walk backward, away from each other, stretching the glass into a thin cane some 40 to 50 yards long. The narrow bore that at the start was about five millimeters in width retains its shape, although it is now so small that it is quite invisible. As soon as the glass has become firm, it is cut into convenient lengths, and samples from different parts of the draft are examined for diameter, formation of lens, and finally a microscopic examination is made of the bore, and on this examination depends whether the workmen are to be paid a high price, a low price, or nothing at all for their labour.

Possibly the question may be in many minds, how, or by what occult power, can the workman ensure that the final product shall conform to the incredibly small limits of bore and other details that the industry demands? The answer is simple. He cannot, in a hundred pounds weight of glass drawn. Twenty, thirty, or perhaps sixty per cent. pass the standard, and the rest goes into the cullet box to be melted up again next week.

Is it, then, all chance?—just a gamble like a throw of the dice? No; I venture to say that it is not. Just as the individuality of the old Greek craftsman put a certain something into that little tear bottle that still lives, there is a certain psychological something that cannot be put into words that enabled the craftsman during the many operations between the start and the finish to say, when he lays down his iron, "That's a dud," or "That's a good 'un" (and he is generally right).

And now, as a reward for your patience in listening to me through this somewhat lengthy detail, I can show you a photograph of the craftsmen I have just described at their work. This is not a made-up picture, but was taken during an ordinary daily operation.

And now for a final word as to the glass industry. I have purposely avoided touching upon the rapid and important advances that have been made, chiefly in America, in the mechanical production of glassware. Machines are now in operation that can turn out finished bottles at the rate of sixty or more a minute without one touch of the hand of the craftsman, but there is, and always will be, a demand for fine glass that can no more be turned out by a machine than could a properly proportioned suit of clothes, and one of the important problems of to-day is—how is that demand to be met?

The late Mr. Harry Powell, in a book recently published, wrote: "The handicraft of glass making is doomed owing to the scarcity of recruits—the training necessary to equip a competent glass blower is long and arduous, and the prospect of ultimate success is not sufficient to attract youths to adopt glass blowing for a trade."

These are very serious words from one who had devoted his life to the subject, and whose successful productions hold the highest place in modern art glassware.

But I, for one, do not take such a hopeless view of the matter. I quite agree that the old method of producing the craftsman must go—has gone! Boys can no longer be sent into the glass house at eight or ten years of age to labour for sixty or seventy hours a week to pick up their trade at odd

moments during the drudgery of acting as fags to the older men, in a few cases to attain to the coveted position of "gaffer" after ten or twenty years' hard work. Modern conditions have changed all that, and unless our educationists are all wrong, and I do not think that they are, the average boy of to-day starts with a good education, a strong, healthy body, and with an intelligent mind that he can concentrate upon his work, and if his moral training has been sufficient to keep him from the many pitfalls that are spread for him by the way, he stands a far better chance of success than did the lad of fifty ears ago.

All that is needed is to adapt the method of training to the conditions of to-day. I have had personal experience in this matter and know the splendid material that is at hand, and although I also know, to my sorrow, the difficulty of persuading the manufacturer to risk the expense and labour of scientifically arranged, intentive training for glass workers, I still have the hope that before I lay this and all other such subjects aside, that I shall see the young man of today, clear-eyed, strong, healthy and intelligent, producing by his skill and to his personal satisfaction and pleasure, fine glassware that shall keep this British industry, as many others, to the forefront among the nations.

THE MOBILITY OF SYMMETRICAL TRIAD SYSTEMS.

PART I.—CONDITIONS RELATING TO THE SYSTEMS TERMINATED BY PHENYL GROUPS.

BY R. F. HUNTER, F.C.S.

In the examination of the mobility of symmetrical tautomeric systems of the general formula, [H]X·Y:X, six systems fall into view: 1, the carboxyl group; 2, the acinitro group; 3, the diazoamino system; 4, the amidine system; 5, the methylenemethylamine system; 6, the three carbon system.

The last four systems are the systems which will be dealt with in this series of papers. Ingold and his research students proposed to investigate the behaviour of these four systems when attached to different types of terminal group. The present paper deals essentially with the terminal phenyl group, and the comparison, therefore, of the four substances:

(1) NH.Ph·N:N.Ph
(2) NH.Ph·CH:N.Ph
(3) CH_2Ph·N:CH.Ph
(4) CH_2Ph·CH:CH.Ph

The proof of the mobility of the three nitrogen system present in diazoaminobenzene, 91-3, rests on two types of evidence, both of which find their parallel in the experiments described hereunder.

Proof that only a single substitution product exists where two substances of the formula (5) and (6) would be expected (*Berichte*, 1873, VII., 1619). Proof that the single individual referred to above on fission at the double bond, say, by reduction or hydrolysis, gives four products, two derived from the two fragments of each of the hypothetical substances (5) and (6), (*Berichte*, 1887, XX., 3005).

(5) X.C_6H_4 NH·N:N.C_6H_5
(6) C_6H_5.NH·N:N·C_6H_4X.

The same two types of evidence have been advanced in relation to diphenylformamidine (2) and its derivatives, by Marckwald (*Annalen*, 1895, 286) and by von Pechmann (*Berichte*, 1897, XXX., 1,783). In view of this it is rather peculiar that at first sight, in turning to the third system, both of the above mobility tests failed when applied to benzylidenebenzylamine (3). Pairs of isomeric monosubstitution products of the types (7) and (8) as well as disubstitution products, were not only very different, but appeared to be incapable of interconversion, each compound, further, on acid hydrolysis, gave not four but two resultants by fission of the double bond, the two being the aldehyde and amine by which the substances were originally prepared.

(7) X.$C_6H_4CH_2$N:CH.C_6H_5.
(8) C_6H_5.CH_2.N:CH.C_6H_4X.

The three carbon system in $\alpha\gamma$-diphenylpropene is of particular interest in view of the analogy with glutaconic acid, the three carbon system of which is known to possess high mobility. The application of the glutaconic acid method was accomplished by Thole and Thorpe (*Journ. Chem. Soc.*, 1911, XC., 2,193), who proved that α and γ alkyl derivatives, which from their methods of preparation should have the structures (9) and (10), were identical.

(9) CO_2H.CHR CH:CH.CO_2H.
(10) CO_2H.CH_2.CH:CR.CO_2H.

On the other hand, in several cases Feist obtained four products on fission by ozone oxidation, two corresponding with the static formulæ. The glutaconic acids respond,

therefore, to the mobility tests, and it was expected that the diphenylpropenes would behave in an analogous manner. It was found, however, that the two phenyl groups in diphenylpropene are not equivalent, and that corresponding with the substitution products of the types (11) and (12) show no tendency to undergo conversion, and further, that each individual on permanganate oxidation gives not four but two fission products corresponding with the static formula assigned to the substance. From this it would appear clear that to produce a tautomeric system it is not sufficient to have a potentially mobile hydrogen atom in the right position—some activating condition is clearly necessary. As to the nature of this, a certain amount of light was thrown on the subject from a consideration of tautomerism in relation to certain other properties of the system under review.

It appears reasonable to assume that the condition of first importance in determining mobility, that the α-hydrogen atom should be capable of easy detachment from the tautomeric system, in the carboxyl and aci-nitro groups the mobility is probably greater than in any other system. We have clear indication of this by the ease with which esterification by an alkyl group takes place. The mobile hydrogen atom in diazoaminobenzene can be replaced by an alkyl group also, but it is necessary to work with an alkyl iodide in the presence of sodium ethoxide, just as in the alkylation of unsymmetrical systems such as ethyl acetoacetate. It will be noted that the systems capable of alkylation are mobile ones. On the other hand, α-γ-diphenylpropene and benzyllidenebenzylamine cannot be alkylated by ordinary methods, and are non-tautomeric.

From the above, the conclusions are that, firstly, the activating condition is associated with easy detachment of the mobile hydrogen atom, and secondly, that the activating condition is one of the well recognised group of related characteristics supposed to be associated with electrical polarity.

Clearly, then, it is that the greatest mobility is observed when the α atom is oxygen, intermediate mobility when it is nitrogen, and least mobility when it is carbon, and hence also that the least mobility is only observed when a definite negative mobility is induced by strongly polar attached groups, as in the glutaconic acids.

The Royal College of Science,
South Kensington, S.W.7.

NOTE ON FIREPROOF WOOD.

By E. R. France, B.Sc. (Hons.).

During recent years, the University of Columbia has been engaged on an investigation of the action of various chemicals and the relative value of various methods employed for the treatment of wood to render it fireproof. Results have recently been published. The four chief processes of preparation are: 1, Immersion in cold solutions; 2, Immersion in hot solutions; 3, Impregnation under pressure in autoclaves; 4, Impregnation in autoclaves, in vacuo and finally under high pressure.

The best results appear to have been attained with the application of the last of these methods; the next best is that under ordinary pressure. The pressures found most suitable range from 50 to 60 lbs. per square inch. With the application of the chlorides of copper, bismuth, iron and zinc and the sulphates of aluminium and barium, the wood ignites at a temperature below 290 degrees. Ammonium and sodium chlorides, boric acid and aluminium sulphate appear to be of little use. On the other hand, the following bodies prevent ignition, even above 300°: chlorides of zinc, magnesium and calcium, ammonium sulphate and phosphate, borax, water glass, zinc phosphate and a mixture of phosphate and borax. Ammonium phosphate appears to be the most effective agent; on heating, it evolves a suffocating gas and leaves a coat of orthophosphoric acid on the surface of the wood. It is understood that these valuable researches are being continued.

GENERAL NOTES.

HELIUM FOR AIRSHIPS.

The proposed exploration of the Polar regions to the north of Canada and Alaska by the United States dirigible, Shenandoah, is attracting international attention. The Shenandoah is the first large airship to be inflated with helium instead of hydrogen, which has always hitherto been used. If this voyage is successful, and is carried out without mishap, the importance of helium for airships will be firmly established.

The destruction by fire of the U.S. dirigible Roma in 1922, and the more recent loss of the French airship Dixmude, emphasises the marked advantages of helium

for this purpose, and has stimulated efforts to establish the commercial production of this gas.

The recent survey of the helium resources of the United States by the Bureau of Mines showed that a large number of natural gases distributed through several States contain up to 0.5 per cent. of helium. A smaller number of gases were found to contain 0.5 to 1.0 per cent., and these are the only ones at present considered suitable for the commercial extraction of helium. The report states that over 50,000,000 cubic feet of helium annually could be obtained by five or six plants, and that in an emergency this volume could be doubled.

The cost of helium produced in the two plants erected at Fort Worth, Texas, during the latter stages of the war, was from $100-$150 per thousand cubic feet. "It is anticipated that this cost will be reduced to $30 in the new plant to be built on the plan of the semi-commercial unit now being experimentally operated." This new plant, which produces helium of 95 per cent. purity in a single stage, was designed on the basis of work carried out in the low temperature research laboratory of the Bureau of Mines. Altogether over $6,000,000 has been spent on the production of helium by the United States Government.

At the request of the British Government an investigation of the helium resources of the British Empire was commenced in 1915, under the direction of Prof. J. C. McLennan, of the University of Toronto.

The results of this survey, published as Mines Branch Bulletin No. 31, showed that natural gas from the Bow Island field in Alberta was the richest known source in the Empire available for commercial production. This gas contained 0.33 per cent. helium. An experimental plant was erected at Calgary in 1919, where about 60,000 cubic feet of helium of varying grades of purity was produced during four months' operation. This plant was dismantled soon after the close of the war, and no further work has been done.

During the past year the Mines Branch of the Department of Mines has commenced a further survey of the Canadian resources of natural gas and helium. This work has included the collection of the latest data on the helium situation. Samples of gases from new wells have already been collected and analysed by Mr. R. T. Elworthy, of the chemical division.

Ontario and Alberta are the principal provinces in Canada in which natural gas occurs in commercial quantities. Several gases in Ontario have a helium content of about 0.3 per cent., especially those from Brant and Haldimand counties, but the supplies are from small wells in declining fields. The quantity of helium that might be extracted would be small.

In Alberta, the Bow Island field is also showing signs of exhaustion. It was calculated in 1916 that about 12,000,000 cubic feet of helium a year could be extracted from the gas supplied to Calgary alone. This estimate was probably too large, and the present annual output would undoubtedly be much smaller, especially as the field is now only drawn upon in winter. Calgary is no longer a suitable location for an extraction plant, as the gas at present supplied to the city is a mixture of gases from the Turner Valley field and from the Bow Island field. The helium content of gas from the former field is very low.

One new source, already discovered, is the field at Foremost, forty miles south of Bow Island. The first well drilled in this area has an open flow of fifteen million cubic feet of natural gas per day, and is the largest gasser in Canada. The helium content of this gas is 0.2 per cent.

Gas from the fields in Central Alberta, at Viking and Wainwright, only contains 0.06 per cent. Gas from Medicine Hat and Many Islands is equally low in its helium content.

PEAT.

The widespread and general interest in the possibility of utilising the extensive peat deposits of Canada as a source of fuel for domestic and other purposes has led to the publication by the Mines Branch of the Federal Department of Mines of a bulletin, entitled, "Facts about Peat."

The present publication, which is comprised within 48 pages and written in non-technical language, aims, as its size and title indicate, to present in "tabloid" form the outstanding facts in relation to the peat resources of Canada, and their possibilities as a source of fuel.

The bulletin indicates briefly the nat re of peat, the difficulties involved in the pr duction of fuel from it, and the underlying principles upon which any successful attempt at manufacturing must be based. A short account is given of unsuccessful ef-

forts made in the past in Canada, and of the methods which were experimented with. The possibilities of removal of water from peat by pressure, evaporation by artificial drying, briquetting, carbonisation and recovery of by-products are discussed. The air-dried-machine peat process, the only process which has so far been employed successfully on a large scale, is described, and the character and value of the fuel manufactured according to this process are discussed, and a number of opinions of users quoted. Other uses of peat are briefly dealt with. Detailed information relating to Canadian peat bogs so far investigated is summarised in tabular form. Tables relating to the production of peat fuel in Canada and other countries are appended, and a short bibliography is included, indicating the principal sources of information on which the bulletin is based.

Since it is probable that the peat resources of Ontario and Quebec may in the near future assist materially in coping with the fuel problem in the acute fuel area of these provinces, the appearance of this bulletin is timely, and should prove of wide interest.

Copies of this bulletin (Mines Branch Report No. 614) may be obtained on application to the Director, Mines Branch, Department of Mines, Ottawa.

DYESTUFFS (IMPORT REGULATION) ACT, 1920.

The following statement relating to applications for licences under the Dyestuffs (Import Regulation) Act, 1920, made during February, has been furnished to the Board of Trade by the Dyestuffs Advisory Licensing Committee.

The total number of applications received during the month was 445, of which 372 were from merchants or importers. To these shoul dbe added 35 cases outstanding on February 1, making a total for the month of 480. These were dealt with as follows:—

Granted—369 (of which 344 were dealt with within 7 days of receipt).

Referred to British makers of similar products—72 (of which 52 were dealt with within 7 days of receipt).

Referred to Reparation Supplies available—22 (all dealt with within 2 days of receipt).

Outstanding on February 29, 1924—17.

Of the total of 480 applications received, 418, or 87 per cent., were dealt with within 7 days of receipt.

The Lord President of the Council has appointed Mr. F. S. Sinnatt, M.B.E. (Mil.), M.Sc.Tech., F.I.C., M.I.Min.E., to be Assistant Director of Fuel Research, as from April 1 next.

Mr. Sinnatt is lecturer in Fuels in the University of Manchester, Faculty of Technology. He is also Director of Research to the Lancashire and Cheshire Coal Research Association, and has been in charge of the physical and chemical survey of coal seams which the Association is carrying out for the Fuel Research Board in the Lancashire and Cheshire coalfields.

In the annual report of the University College (London) for the session 1923-24, reference is made to the new department of Chemical Engineering which has been established to provide for students of chemistry a sufficient training in engineering to make them effective chemists able to meet modern conditions in chemical work. The Chemical Engineering Laboratory is named after the late Sir William Ramsay.

The Photographic Section at the Ideal Home Exhibition, Olympia, should attract the general public and induce people to take a greater interest in photography. The pictures exhibited are fine examples of what can be done by means of the camera. Recent developments of scientific interest in photography are shown by several of the firms exhibiting.

THE NATIONAL COUNCIL OF TECHNICAL STAFF ASSOCIATIONS.

It is now becoming generally recognised that it is necessary for technical engineers, chemists, scientific workers, and other allied professional men to be organised if their interests are to be protected and promoted and if they are to attain collectively an effective voice in the furthering of the welfare of industry.

The last few years have seen a remarkable growth of Societies for these purposes, but whilst many of them which have arisen

in such industries as electricity supply, engineering, and chemical manufacture, etc., have been partially successful in advancing the economic welfare of their members, they have found by experience that owing to their isolation from one another, and their comparatively small numerical strength, they have been unable to exercise that influence or acquire that prestige to which the professional standing of their members entitles them.

When questions of general policy affecting industry have been made the subject of legislative enactment, the technical staffs have rarely been consulted, and even when they were in a position—by virtue of their special knowledge—to make a contribution of service to industry or the State, the opportunity has not been open to them. Though, admittedly, it is upon them that the development of industry largely depends, their collective voice has practically been ignored hitherto when industrial questions have been under consideration, or when the conditions under which their work is carried on have been settled.

The National Council of Technical Staff Associations has recently been formed with a view to remedying this deficiency. Its main object is to link together the activities of the various protective organisations of technicians in industry.

The Council looks to all who have at heart the welfare of technical engineers, chemists, and other scientific workers, to support the movement. Joint Secretaries have been appointed, whose offices are at 23, King Street West, Manchester, and 102, Belgrave Road, London, S.W.1.

THE AREAS UNDER WINTER CEREAL CROPS.

The International Institute of Agriculture has published data of the areas sown with winter cereals, in a group of countries where are usually comprised about 75 per cent. of the aggregate winter wheat crops, and about 55 per cent. of those of rye, throughout the northern hemisphere (exclusive of Russia). The available figures indicate a decrease of 5.5 per cent. in the wheat area, and 1 per cent. in that of rye, as compared with last year. The chief among cereal producing countries that have not yet furnished returns (apart from Russia) are Germany, France, Italy, the Serb-Croat-Slovene State, and Hungary. It appears probable that the winter sowings in Russia are slightly larger than those effected in 1922. In other European countries whence data are still unavailable, there is reason to believe that the aggregate area under winter cereals is almost similar to that sown last year.

On the basis of the data and other information to hand, it may be estimated that the aggregate winter wheat area in the northern hemisphere is below that of 1922, mainly owing to the ascertained decrease in the United States. A definite opinion as to the total area for the wheat crop of 1924 in the northern hemisphere cannot be formed until that of spring wheat sowings is available.

Spring sowings are of considerable extent in North America; last year 22 million acres were cultivated in Canada, and 19 million in the United States.

In Europe, outside Russia, the winter wheat is predominant, and spring cultivation of this crop is of secondary importance.

The aggregate winter rye sowings in those European countries whence data are to hand indicate an increase, sufficient to compensate, in great measure, for the decline notified from the United States.

PROCEEDINGS AND NOTICES OF SOCIETIES.

THE ROYAL SOCIETY.

THURSDAY, MARCH 13.

Papers read:—

PROF. A. FOWLER, F.R.S. *The Series Spectrum of Ionised Carbon (C II).*

The production of previously unrecorded lines of carbon has led to the identification of the leading members of the series of ionized carbon (C II or C+) in the ordinary region of observation. The main series, however, lie in the extreme ultra-violet, and were identified in the observations of Simeon and Millikan with the aid of the spectral terms thus determined. The series of C II form a doublet system, like the spectra of boron and other elements of Group II., as would be expected from the spectroscopic displacement law. The highest terms are the common limits of the sharp and diffuse series, 196612 and 196670, from which it may be deduced that the second ionization potential of carbon is 24.3 volts.

In the normal state of the atoms, two of the outermost electrons in ionized carbon appear to move in 2_1 orbits, while the electron which generates the spectrum traverses a 2_2 orbit, as suggested by Bohr for neutral boron.

PROF. W. L. BRAGG, F.R.S. *The Refractive Indices of Calcite and Aragonite.*

Calcite and aragonite, two crystalline forms of calcium carbonate, are closely related in their optical properties. Both crystals possess strong negative birefringence, and their refractivities are nearly identical when allowance is made for the small difference in molecular volume between the two. The crystals have been analysed by X-ray methods.

The strong double refraction is to be ascribed to the peculiar form of the CO_3 group. This consists of three oxygen atoms grouped around a central carbon atom and lying in a plane. The oxygen atoms are more highly polarized by an electric field than the other atoms in the crystal. The three atoms in the same CO_3 group, when they become electrical doublets, exert a strong influence on each other, which results in their being more strongly polarized by an electric field parallel to the plane of the group than by a field perpendicular to the plane of the group. Hence the refractive index of the crystal is greater when the electric vector is perpendicular to the trigonal axis of calcite than when it is parallel to the axis. The same holds for the pseudo-hexagonal axis of aragonite.

A numerical calculation of the effect shows that it accounts quantitatively for the difference in refractive indices, both for calcite and aragonite. Values for the refractivities of the calcium and oxygen atoms are assumed which are based on the refractivity of a number of compounds. When these are substituted in the formulæ which are derived, the calculated values of the refractive indices do not differ by more than 1 or 2 per cent. from the observed values. Thus:—

	Calculated.	Observed
Calcite ϵ	1.488	1.486
,, ω	1.631	1.658
Aragonite α ...	1.538	1.530
,, β ...	1.694	1.681
,, γ ...	1.680	1.686

KATHLEEN YARDLEY. *The Crystalline Structure of Succinic Acid, Succinic Anhydride, and Succinimide.* Communicated by Sir William Bragg, F.R.S.

The monoclinic holohedral crystal of succinic acid is shown to possess two molecules per unit cell, and is based on the Bravais lattice Γ_m. Each of these molecules has a plane of symmetry, and they may be brought into coincidence with each other by a screw of angle 180° and translation $\frac{1}{2}b$; thus the space-group to which the crystal belongs is $C_{2h}{}^2$. A probable structure is discussed in detail, an explanation of cleavage and twinning being given.

The orthorhombic crystal of succinic anhydride is based on the lattice Γ_0 and has four molecules per cell. It is shown that the X-ray method fails to determine the class to which the crystal belongs; the space-group is either C'_{2v} or Q'_h, and the molecule is either asymmetric or possesses a plane of symmetry.

In the unit cell of the orthorhombic holohedral crystal of succinimide there are eight asymmetric molecules, the fundamental lattice being Γ_0. The space-group is proved to be Q'_h, and details of a probable structure are given; a comparison of the molecules of succinic acid and of succinimide is made.

L. F. BATES and J. S. ROGERS. *Particles of Long Range from Polonium.* Communicated by Prof. Sir Ernest Rutherford, F.R.S.

Polonium has been examined by the scintillation method for the emission of long-range particles, and it has been found that for every 10^7 α-rays of range 3.93 cm. emitted there are also present 98, 51, and 26 particles of ranges 6.1 + 0.1, 10 + 0.1 and 13.1 + 0.2 cm. respectively, together with about 7 particles of longer range which are probably H-particles. It is considered from the relative brightness of the scintillations alone that these particles are α-rays. Also from the evidence available it is deduced that these particles are emitted by polonium itself.

A. MULLER. ***On the Determination of the Crystal-Axes in "Single-Crystal" Aluminium Bars by means of X-Rays.*** Communicated by Prof. Sir Ernest Rutherford, F.R.S.

In connection with the work of Mr. G. I. Taylor, F.R.S., and Miss C. F. Elam on the distortion of aluminium crystals during a tensile test (Bakerian Lecture, 1923), the

author investigated by means of X-rays the aluminium bars used by Taylor and Elam. It was found that these kept their lattice structure even when stretched to a considerable extent. A description is given of the method developed for the determination of the orientation of the axes of the lattice relative to a fixed plane in the test-piece.

At the meeting of May 15, PROF. A. FOWLER, F.R.S., Yarrow Research Professor, will deliver the Bakerian Lecture on *The Spectra of Silicon at successive Stages of Ionization.*

THE ROYAL SOCIETY OF ARTS.

A Study of the Destructive Distillation of Coal, by E. V. EVANS, F.I.C.

(*Continued from Page* 170.)

In order to show clearly the composition and thermal value of the gases obtained by carbonisation under normal conditions, it is possible to construct a model from the analysis curve. The lower portion of fig. 8

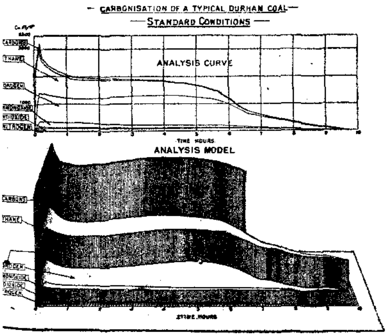

Fig. 8.

shows the structure of such a model, and is composed of sections representing the different constituents of the gas. The height of each section represents the calorific value of the constituent, and the breadth, the volume produced at any one moment during carbonisation. By looking down on the model in plan, a simple reproduction of the stratified analysis curve is seen, and the analysis model is produced by making height of each constituent proportion: its calorific value.

The production of inert constituent fairly constant up to the seventh hour; bon monoxide is evolved fairly evenly the eighth hour, when it tapers off; v hydrogen gradually increases during the bonising period until a maximum is tained about the fourth hour. Met production is at its height in the first minues, and tapers off sharply until at end of the second hour a fairly cons quantity is being produced. The uns ated hydrocarbons, important though are as regards their contribution to cal value, are quite small in volume, and off at the sixth hour. Whereas the ana curve shows the hourly production of constituent of the gas, the analysis n demonstrates the contribution of eac the total thermal yield and also to the tive work at any one moment during bonisation. It thus shows in a convi manner the true value of each constit In the case of the inert constituents, i gen, carbon dioxide, and oxygen, it i vious that as these possess no calorific they will be represented without heig the model. The outstanding feature o model is the layer representing the saturated hydrocarbons which disappe the end of the sixth hour. This laye

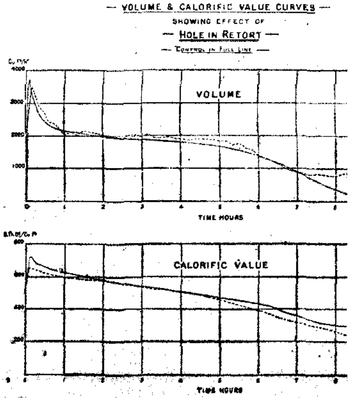

Fig. 9.

considerable height owing to the high calorific value of the unsaturated compounds. It is practically a knife edge owing to their small volume.

Reverting to the soundness of the retort and its effect upon the nature of the gas made and the yield of gaseous therms, fig. 9 gives the results when working under standard conditions, but with a hole of ½in. diameter in the retort at a point equivalent to the centre of a 20ft. retort. The broken curves show (with the control curves) the changes in volume and calorific value resulting from the hole. Whereas the volume peak is reduced at the commencement, due to loss of rich gases, the volume is increased throughout practically the whole of the remaining period of carbonisation. This is probably due to more rapid carbonisation taking place as the result of the scouring action of the furnace gases pulled into the retort, and to the furnace gases themselves. On the other hand, the calorific value of the gas is lower throughout, that of the final gas being 482 B.Th.U., as against 532 B.Th.U. in the control experiment. But manufacture of gas does not stop at the tenth hour, for at this period there is being produced about 700 cubic feet per hour of a gas of 180 B.Th.U. per cubic ft. This is producer gas (see fig. 10).

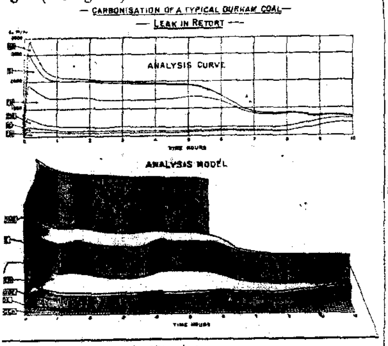

Fig. 10.

The effect of the producer gas reaction is clearly shown. The large increase in nitrogen in the tailing-off gas is to be expected, but it is surpriaing that the time of contact in the retort is sufficient to convert the carbon dioxide, of the waste gases to carbon monoxide, at the expense of the coke.

The thermal yield of gas is about 75 therms per ton, but is dependent upon the time the charge remains in the retort. It is difficult to determine what is the precise thermal yield of true coal gas under these conditions, as it would be necessary to know at what stage the producer gas reaction commenced. Rough calculations from the analyses show that 1 to 2 therms of true coal gas have been replaced by producer gas therms.

The thermal models constituted a device for detecting any slight differences in the carbonising process, or for determining the effect of any adjustments of the conditions of working. For obtaining a high thermal yield it has been found necessary to reduce the vacuum in the hydraulic main of any one section to level gauge when some of the retort doors of that section are open for charging or discharging. As hourly charging is adopted, it is thus the practice to reduce to level gauge for 10 minutes during each hour. An examination of the thermal model will show that at these periods there is a definite indent in the volume curve, and that immediately following this, when the vacuum is re-established, there is a corresponding peak in the calorific-value curve. It is evident, therefore, that gas has been throttled-up during this period of level gauge. Generally speaking, this method of

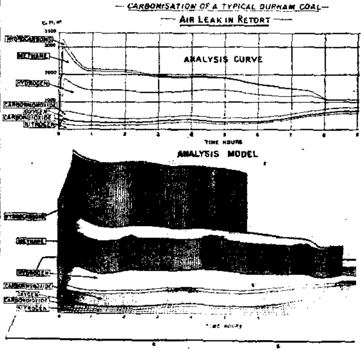

Fig. 11.

procedure does not materially affect the thermal yield of gas, provided the retorts are tight. This practice is disastrous in the case of unsound retorts.

The admission of air is even more to be avoided than the presence of a leak in the retort The damage caused is apparent from fig. 11. The destruction of the hydrocarbons by the introduction of oxygen is indicated by the high CO_2 content of the gas throughout carbonisation, and the producer-gas reaction proceeds in much the same way as in the pierced retort.

The effect of a leakage in the door of the retort is shown in the curves of fig. 12.

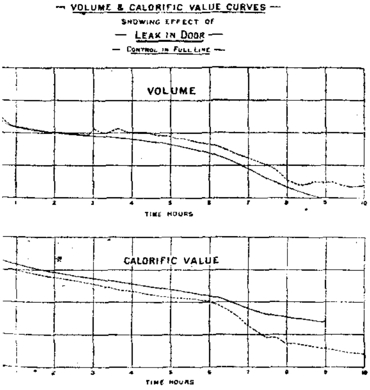

Fig. 12.

Again a quantity of rich gas is lost in the nitial stages of carbonisation, while the volume of gas during the last few hours is ncreased. The calorific value of the gas is also lower than under normal conditions. The analysis model and curves. fig. 13, show that a very different set of reactions must have occurred. Air drawn in at the mouthpiece produces combustion of the gas

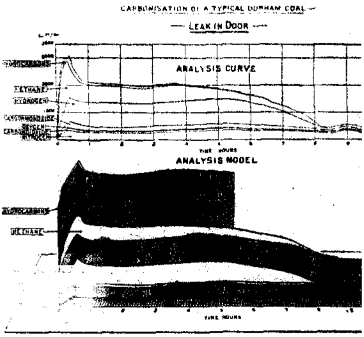

Fig. 13.

and tar in the ascension pipe, which is thu converted into a tar distillery.

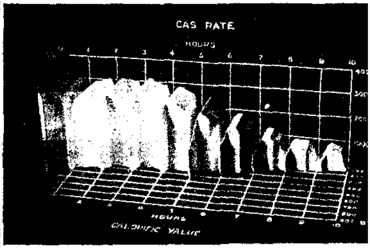

Fig. 14.

Fig. 14 shows how disastrous it is in a pierced retort to bring the vacuum to leve when the retort doors are open for discharg ing and charging (fig. 15).

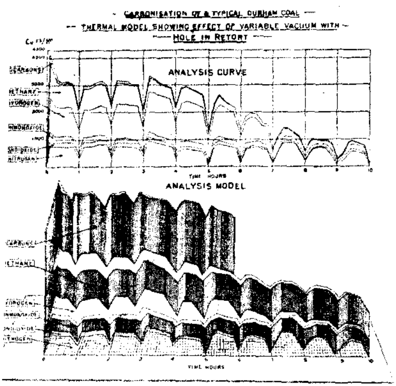

Fig. 15.

At each period of releasing the vacuum a large loss is realised, and the curves become almost mountainous.

THE SOCIETY OF GLASS TECHNOLOGY.

(*Continued from page* 175.)

Continuous High Temperature Measurements in Glass Works, by W. M. Clark, Ph.B. (U.S.A.).

In the strictest sense of the term, there was probably no absolutely accurate method existing for constantly determining glass-house temperatures. We could only approach this desirable aim by refinements of installation and careful maintenance, and this meant both equipment and maintenance expense. Therefore, in considering the subject of a pyrometer installation the glass manufacturer must balance the factors of what his demands for accuracy will be worth against the initial and operating costs of various systems. It is always advisable to instal both the indicating and recording type of instrument, side by side.

Experience at a number of modern well laid out plants showed that pyrometric measurements were reflected in the costs sheets. The morale of the furnace men was improved by eliminating the human errors of judgment in guessing at temperatures and cost per unit of output decreased. With improvements in pyrometric equipment the tendency was for their more extensive use around glass works. The depreciation on such equipment was not excessive, about 10 per cent. per annum being a fair amount judging from successful installations, and as improvements came along they could be incorporated into the system, replacing features which became obsolete, and thus keeping the installation up-to-date. A well planned system would reduce overall costs in a year more than sufficient to pay for the investment, and often would leave several times this amount if used intelligently.

The most forceful argument for the adoption of pyrometer control in a glass works was on the score of economic savings, but the information thereby made available to the management and staff was also important in showing each man a tangible effect of his operation on the thermal conditions. The producer man saw that good gas was necessary to maintain temperature, the furnace man saw the result of proper draught regulation, the foreman of the finishing department could be satisfied whether the ware was being properly annealed, and the whole schedule of production was benefited.

Recent Advances in the Design of Temperature Measuring Instruments, Etc., by R. W. Whipple, F.Inst.P.

One difficulty in connection with disappearing filament pyrometers was to get two lamps which would be interchangeable. Methods for overcoming this difficulty were indicated. The speaker then said how greatly he had been impressed with what he had seen recently in the United States in the matter of automatic temperature control. He understood considerable work was being done in this connection in glass works, and referred to the works of Messrs Keuffel & Esser, where lehr temperatures were controlled from 200° C. to 600° C. For every kind of glassware a special cooling curve was followed. In the United Kingdom automatic temperature control was being developed. The main principle in such control was a galvanometer needle which was deflected by some method. Lantern slides were then exhibited, showing various forms of controller, including (1) Brown, (2) Bristol, (3) C. Engelhard, (4) Leeds & Northrup, (5) Cambridge, (6) Bar (7) Althorpe. It should be possible to control lehr temperatures by some such aut

matic control apparatus, and so to lessen the worries of the works manager.

Practical Applications of Pyrometers to Glass Works, by C. E. Foster, F.Inst.P.

Both optical and total radiation instruments were calibrated for what were known as "black body" condition, and when used on hot bodies which were not technically what were known as "black bodies," the reading would be in error by an amount which varied with the actual condition. An ordinary large glass melting tank was by no means a "black body." The author suggested that luminous gas flames might have the power of selective emission, that is, they radiated a light which was not in proportion to their temperature, but might be of an intensity which would correspond to the brightness of a solid hot body at a much higher temperature. Considering a surface of molten glass viewed obliquely in a furnace that did not realise "black body" conditions, it obviously had a considerable reflecting power, but he found that its reflecting power as experienced in measuring with a total radiation pyrometer was relatively much less than the unoxidised surface of molten metal. Further consideration showed that this was reasonable because there was some considerable transparency in the glass so that it would actually emit a greater proportion of the heat from inside. Thus it was actually found that molten glass approached more nearly to a true "black body" than unoxidised molten metal.

Reflections on Pyrometer Design, by W. Bowen.

Economy in fuel consumption, long life of furnaces or other heating devices employed, elimination of waste of raw materials and of irreparable losses of finished products all depend upon the raising of the heat-treated materials to no less, and no more, than the requisite temperatures. The value of pyrometers to such heat-treatment problems was now too well recognised to need discussion. A few of the standards which a good pyrometer should fulfil were as follows: (a) Simplicity of design and operation, (b) robustness and freedom from liability to breakdown under shock or accident, (c) flexibility of apparatus to meet practical conditions, (d) long and stable life of pyrometer, (e) speedy response to temperature changes, (f) automatic action, (g) accuracy. These standards were then discussed with reference to the new "Pyro" radiation pyrometer, an instrument compact in shape, extremely portable, and simple in operation.

NOTICES OF BOOKS.

Allen's Commercial Organic Analysis, Fifth Edition, Vol. 1; Edited by Samuel S. Sadtler, S.B., Elbert C. Lathrop, A.B., Ph.D., and C. Ainsworth Mitchell, M.A., F.I.C. Pp. VIII. + 796. London: J. & A. Churchill, 7, Great Marlborough Street. 1924. 30s.

This treatise on the properties and analyses of organic chemical products is one of the most valuable in all the literature dealing with analysis. It is therefore a gratification to find that well-known English and American specialists are undertaking its revision.

The first revised volume, now published, gives the methods for detecting and estimating such aliphatic products as the alcohols, yeast, malt, wines, sugars and starches, cellulose preparations, and the aliphatic acids.

The lengthy introduction has undergone no noticeable alteration, although the authors must be aware of important improvements and additions to the apparatus at the analyst's disposal. In other sections, however, much new matter has been incorporated.

Succeeding volumes are awaited with interest.

Chemical Synonyms and Trade Names —A Dictionary and Commercial Handbook, by William Gardner. Pp. IV. + 271. London: Crosby, Lockwood & Son, Stationers' Hall Court, Ludgate Hill, E.C.4. 1924. 25s. net.

Many hundreds of chemical compounds have two or more technical and commercial designations. This is apt to lead to confusion. The object of the present volume is to give the synonyms and trade names, sometimes with brief notes, for all materials commonly used in chemical industries and pharmacy. It includes minerals, dyes, explosives, alloys, pigments, drugs and other substances. The work is arranged alphabetically, and abounds in cross-references.

The book will be of considerable service, both to chemists and to manufacturers and dealers. There are many chemicals, the trade names of which are unfamiliar to

chemists. The commercial world is even less acquainted with the accurate scientific and technical names for products of sometimes very common use.

New Patents.

This list is specially compiled for The Chemical News by Messrs. Rayner & Co., Registered Patent Agents, of 5, Chancery Lane, London, from whom all information relating to Patents, Trade Marks, and Designs can be obtained gratuitously.

Latest Patent Applications.

5345—Badische Anilin and Soda Fabrik—Manufacture of *alkali cyanide*. March 1.

4967—Michael & Co., J.—Production of *soluble barium salts*. Feb. 27.

4932—Karpen & Bros.—Manufacture of *hexamethylenetetramine*. Feb. 26.

5219—Millar, J. T.—Crystallisation and drying of *soluble substances*. Feb. 29.

Specifications Published this Week.

207142—Henkel et Cie. and Weber, Dr. W.—Process for treating ammonium chloride lyes in iron vessels.

196938—Goldschmidt Akt Ges. T., Schertel, L., and Luty, W.—Process for refining tin.

211234—Lewcock, W., Voss, W. A., and Gas Light & Coke Co.—Manufacture of sulphurised dyes from carbazole derived indophenols.

Abstract Published this Week.

209697—Synthetic resins.—Stokes, J. S., Spring Valley Farms, Pennsylvania, U.S.A.

Urea-carbohydrate condensation products.—Synthetic resins are produced by condensing carbohydrates, preferably polyoses, with urea with or without a catalyst such as an acid, and subsequently incorporating a methylene hardening agent. The products are potentially reactive or infusible and insoluble according to the degree of heat and pressure to which they have been subjected. An example shows the proportions of urea, corn starch, and sulphuric acid, which may be used. The reaction is carried out and the products are utilisable in exactly the same way as described in Specification 208193, which employs phenolic bodies instead of the urea.

Messrs. Rayner & Co. will obtain printed copies of the published specifications and abstract only, and forward on post free for the price of 1s. 6d. each.

THE OWNERS of British Patent No. 160366, relating to Improvements in Glass Blowing Machines, are desirous of getting the invention taken up in this country, either by sale of the Patent or by the grant of a licence or licences to manufacture on royalty.—Enquiries to be addressed to A. & I., 30, Southampton Buildings, London, W.C.2.

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THE CHEMICAL NEWS,

VOL. CXXVIII. No. 3337.

A STUDY OF THE DESTRUCTIVE DISTILLATION OF COAL.

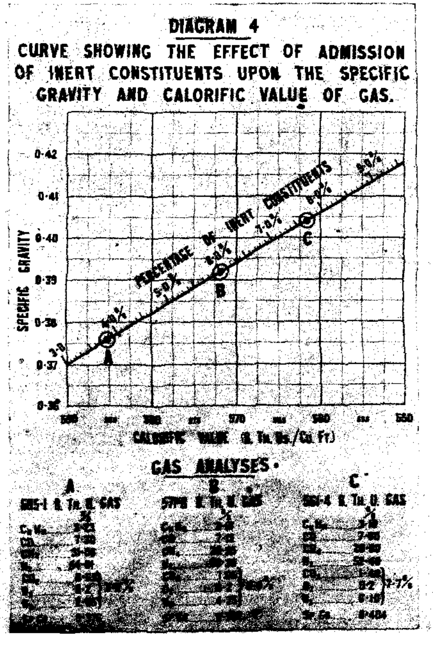
By E. V. Evans, F.I.C.

The Second of Three Cantor Lectures delivered before the Royal Society of Arts, March 3.

(*Continued from Page* 190.)

It was shown in the first lecture that to determine alone the gaseous thermal yield in the carbonising process was useless from the viewpoint of computing the efficiency of the process. Though high gaseous thermal yields could be obtained with a hole or a leak in the retort, there was always a loss of true coal gas, the extra gas therms being made indiscriminately at the expense of another therm-containing constituent of the coal. The greatest economy was to be attained by carbonising in a tight retort, and, if dilution were needed, it should be done by the admission of the diluent under perfect control.

If a system of tight retorts is operated at a combustion-chamber temperature of 1300° C., and maintained under a reasonable vacuum of 3 tenths water gauge, the gas manufactured possesses the characteristics shown under A in Fig. I. Such gas contains so small a percentage of inert constituents, and consequently so low a density, that it is unsuitable for use in the inverted bunsen-burner. There are many methods of adjusting the composition of this gas, as, for example, by adding water gas, producer gas, or waste gases. It was imagined that the



least economic method would be to reduce the calorific value by raising the temperature of distillation, whereby undue degrada-waste gases is shown in Fig. I. It was decided to add waste gases to the crude gas prior to purification. The effect on its calorific value and specific gravity of adding waste gases is shown in the figure. It was desired to add a proportion of waste gas sufficient to remove point A on the curve to B, to produce a gas of 572 B.Th.U., which, upon subsequent admission of air to the purifiers, would be reduced to the desired calorific value. The calorific value curves shown in fig. II. demonstrate, in the case of the two upper charts, the nature of the gas made in the retort-houses and before adjustment, and in the lower chart the nature of the gas after dilution. It will be seen that a gas of remarkably constant calorific value is delivered into the holders.

In controlling the carbonising process, it is necessary to determine not only the yield of gas therms, but also of tar therms, for the one is convertible into the other. These, together, give the "volatile therms." Results of working may thus be expressed as follows—that there has been obtained a total yield of 90 volatile therms, of which 73 are in the form of gas.

The introduction of the therm system has rendered practically useless the investigations of men in the gas industry who have expressed their results in terms of cubic feet of gas of a certain illuminating power per ton of coal. The absence of data relating to the calorific value of the tar recovered is not so serious an omission, in view of the fact that an average figure may be taken for the purpose of ascertaining a very approximate tar thermal yield. The results of sound investigations in the gas industry to-day are expressed upon the basis of the thermal yield of each of the products, gas, tar and coke, but many of the reports, dissertations, and claims appearing in our gas literature to-day are entirely misleading, as they are made by investigators who have failed to appreciate the thermal inter-relation between the three products derived from the carbonisation of coal. While one works is able to obtain 80 therms of a gas which is obviously not true coal gas, another obtains a high yield of a gas the analysis of which indicates that it must have left behind pitch, instead of tar. No data, however, are given concerning the yield and nature of the resulting tar, so that it is impossible to obtain any accurate conception of the efficiency of the carbonisation process.

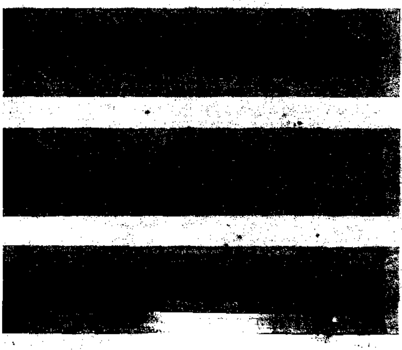


Fig. II.

If the whole of the volatile matter is expelled from the coke, then there is a certain limit beyond which gas must be manufactured at the expense either of coke or tar, and the investigator who, in studying the effect of certain carbonising conditions, overlooks this, obtains results which bring little enlightenment to the industry.

An investigation was made to determine the effect of the rate at which the coal charge is heated upon the relation between the yield of gas therms and tar therms. Tests were carried out upon only 100 grams of coal, but, to secure uniformity, a large sample was finely ground, and small briquettes were made (without binding material), for the purpose of obtaining homogeneous samples.

The apparatus used for these trials consisted of a 2 in. diameter silica retort 24 in. in length, packed at its closed end with asbestos. This retort was charged with five cylindrical briquettes placed end to end, and occupying some 7 in. length within the retort. A pyrometer was fitted to the retort, which was plunged either into a fully heated furnace or into one the heat of which was gradually increased over a definite period, the final temperature attained within the retort being the same in all cases. A sectional view of the furnace is shown in fig. III., while fig. IV. shows the whole apparatus. The author wishes it to be assumed that the construction of the apparatus, and its manipulation, together with weighing

and analytical operations, were carried out in an approved manner.

The final temperature attained in this series of carbonisations was 1000° C., and the time taken to attain this temperature varying from 18 minutes to 13 hours. In the first experiment the retort was placed in a furnace already heated to 1000° C. In this respect this experiment differed from the remaining carbonisations, in which the furnace was gradually heated up until a temperature of 1000° C. was attained in the retort within the required time. An important point to be made is that, however quickly the final temperature was reached, the carbonising process was always practically finished at this stage; and though each test was extended for some time after the final temperature was attained, the quantity of the products distilled was small. In computing the results of all experiments, a correction has been made for the residual gas in the retort and other apparatus at the end of the experiment by adding 1.5 therms per ton to the yield of therms calculated from the volume of gas actually collected and its calorific value. This figure was based upon an experimental determination of the approximate composition and volume of the residual gas.

FURNACE USED IN TAR CRACKING EXPERIMENTS.

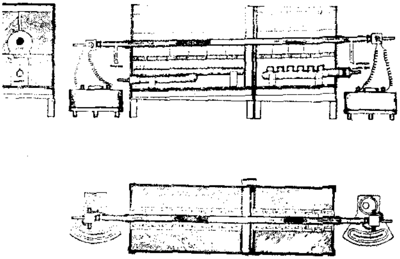


Fig. III.

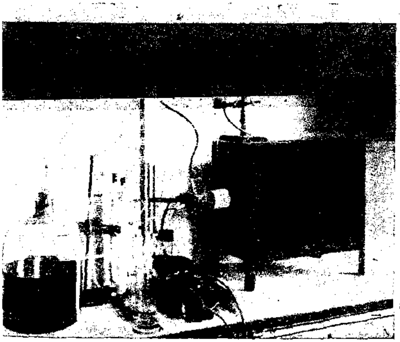


Fig. IV.

It has been ascertained that the yield by weight and the total thermal content of the coke increase slightly as the rate of heating decreases. The tar by weight and thermal content increases rapidly to a certain maximum, and then falls off. The thermal yield of gas falls rapidly as the rate of heating decreases, until a certain limit is reached, beyond which there is no further reduction. The carbon and pitch (which is the material other than coke left in the retort after the test) falls to a minimum both in weight and thermal content, but again rises with exceedingly slow carbonisation.

The most important observations to be made in connection with the relationship between gas and tar therms are: — (*a*) The total volatile therms show a gradual decrease as the rate of carbonisation becomes slower. There is thus a lower, rather than a higher, yield of volatile therms resulting from slow and careful carbonisation. (*b*) Though the yield of total volatile therms falls but gradually with a reduction in the rate of carbonisation, the ratio of gas therms to tar therms varies considerably. Whereas rapid carbonisation favours the production of gas, slow carbonisation, up to a point, preserves tar yields.

As the first of these observations appeared to be contrary to preconceived ideas of carbonisation, it was proposed to carry out carbonisation in two stages, to ascertain whether this would still give a low yield of volatile therms. The yield of tar was high, but the gas was poor. The total yield of volatile products was of the same order as the yields obtained in the moderately slow carbonisations.

The outstanding conclusion to be drawn is that there is a tendency for the highest volatile therm yield to be obtained by prac-

tising the most rapid heating possible; and, while such a condition is certainly conducive to *high gaseous thermal yields*, slower and more careful distillation is a tar-conserving process, and exceedingly slow distillation a *coke-conserving one. Beyond this, the* work is only of academic interest, as the conditions of these experiments are not directly comparable with large-scale working of to-day. The excellent results obtaned *in these experiments are explicable*, and have formed the basis of further investigations of the principles of obtaining enhanced yields of volatile therms.

Returning to the important question of *the extent to which tar may be profitably* cracked into gas, certain chemical aspects of the mechanism of tar cracking should be presented. By this means it is possible to demonstrate that there is a limit to the quantity of gas which may be produced from tar, the over-stepping of which limit results in the deterioration of the tar to such an extent that the process becomes untenable. It is almost unnecessary to explain that in the production of gas at the expense of tar—which is proceeding to a varying extent at all stages of coal-distillation—*it is not a certain proportion* of the tar which is changed into gas, leaving the remainder unchanged, but the character of all the tar is entirely altered, as regards both its physical properties and *chemical* constitution. The brown limpid fluid obtained under conditions of slow heating is replaced under the conditions of rapid heating and high temperatures by a thick black *tar which becomes more and* more viscous with increasing decomposition. These points are very well developed in fig. V., *which shows the* analyses of tars obtained by carbonisation at increasing temperatures. With increasing temperatures the naphthenes, paraffins and phenols gradually disappear, while the pitch content is augmented. Another point which may be seen from the table is the degree of decomposition which has taken place in the pitch, as exemplified by its free carbon content, which is 8.6 per cent. in 500° C. tar, and 36.1 per cent. *in* 800° C. *tar*.

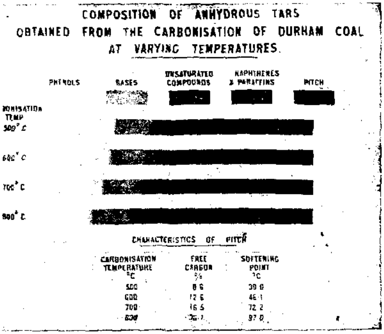
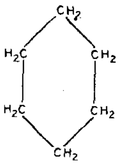


Fig. V.

The tar obtained from quite a low-temperature distillation may now be regarded as primary, and that from a high-temperature distillation as secondary. Investigations are proceeding at the present moment into the constitution of these primary tars, and some of the work is leading to such interesting conclusions, and would form such a delightful subject-matter for lectures, that the author has almost been tempted to incorporate some of it in the present series. There is, however, little satisfaction in presenting the work of others, and it is proposed only to refer, therefore, to the recent work of Franz Fischer and his collaborators upon the constitution of phenols of high and low temperature tars. This important class of constituents is common to both primary and secondary tars, but their individual members are markedly different in the two cases, and their study presents much fascination to those attempting to interpret the carbonising process.

The most important class of compounds in primary tar consists of closed-ring hydrocarbons. They may be either fully saturated, as cyclohexane, (C_6H_{12}), or only partly



saturated, as cyclohexene, (C_6H_{10}). To trace the mechanism of tar cracking, it is proposed to consider the effect of heat upon these typical members. Complex though

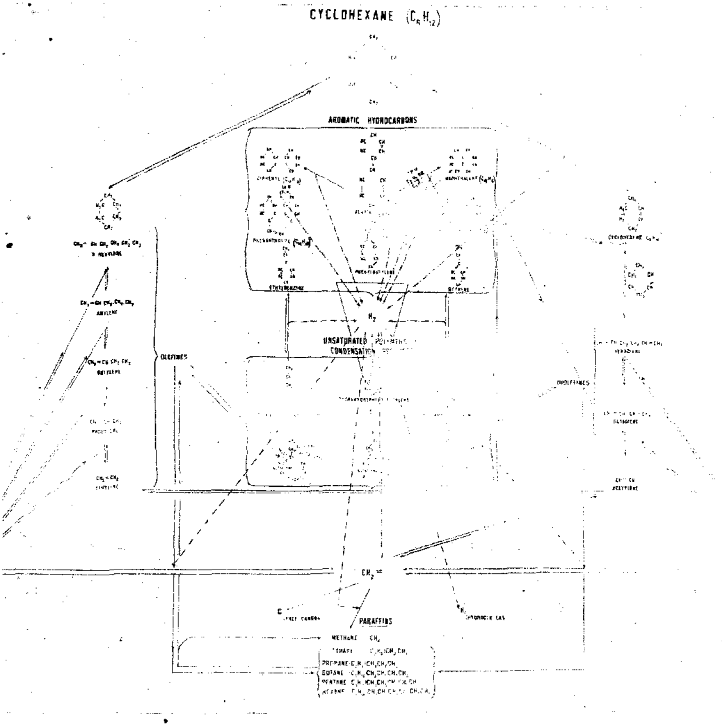


Fig. VI.

the reactions are, they are not so complex as in the case of the phenols, for cyclohexane only contains atoms of carbon and hydrogen in the molecule, while the phenols also possess oxygen.

Cyclohexane is found to be specially resistant to attack by most reagents. Resistant though it may be to chemical attack, the molecule is very unstable at high temperatures, and from this compound there may originate innumerable bodies, solid, liquid and gaseous. The thermal decomposition of cyclohexane has been studied by several workers (notably by D. T. Jones), and the author has also made a study of the liquid and gaseous products of decomposition. This forms the basis of the diagram (fig. VI.) representing the course of decomposition of this hydrocarbon. Though some of the reactions indicated may be hypothetical, they are based on facts supported by experiment. The object of this picture is to allow some small appreciation of the innumerable reactions likely to take place in the retort.

(To be continued.)

British Empire Exhibition,

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AJAX ANILINE DYE MANUFACTURING CO. LTD.

The exhibit will consist of a good selection of dyed samples, showing the firm's colours on all kinds of material, and also a case showing bottles of actual dyestuffs and intermediates.

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A specially interesting feature will be a display of selected tablet preparations showing the distinctive forms of solution tablets (or solvellae), and tablets for internal use. The advantages of tablet preparations from the point of view of convenience and accuracy in the preparation of solutions of definite strength for medicinal purposes are now well known, and need not be emphasised.

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A complete model of their works in Nottingham, and enlargements of photographs of various portions of their plants will be on view.

A souvenir booklet will be distributed at the firm's stand.

The following special literature will also be available for distribution:—

1.—A catalogue of research chemicals, over a thousand of which are now included in their list.

2.—Descriptive booklets, dealing with: (a) Chloramine antiseptics, (b) flavine antiseptics, (c) saccharin, (d) stabilarsan, (e) insulin.

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This company, known universally as the "B.D.H.," was formed in 1908 by the amalgamation of several leading London firms of manufacturing chemists and wholesale druggists, each one of whom was established more than 150 years ago. The firms were: Davy, Hill & Co. (comprising A. S. Hill & Son, founded in 1755, and Davy, Yates & Co., founded in 1760); Hodgkinsons, Clarke & Ward, founded in 1762; Barron Harveys & Co., founded in 1780; and Hearon, Squire & Francis, founded in 1714.

An important addition was made to the export trade of the company in 1919, when the old-established businesses, founded in 1798, and known as George Curling, Wyman & Co., and John Wyman, export wholesale druggists, were incorporated with the B.D.H. The pooling of resources effected by this amalgamation resulted in the company extending very considerably its overseas activities; so that the numerous B.D.H. products are now shipped to practically the whole of the civilised globe, and have established a world-wide reputation for quality. The company has either

branches, resident representatives, or exclusive agencies in all the more important markets, and its products are shipped regularly to all British Overseas Dominions, Brazil, Argentine, Uruguay, Paraguay, Chili, Bolivia, Columbia, Central Europe, Near Eastern and Far Eastern Europe, China, Barbados, Jamaica, West Indies, and other markets.

The company manufactures a range of chemical and pharmaceutical products which is probably larger than that of any other concern in the world. The exhibit at the British Empire Exhibition (1924) comprises some representative and notable examples of the company's products. No attempt could be made to exhibit the whole range, though the examples selected give some idea of the great variety and high quality of the company's products.

B.D.H. Exhibit.—This exhibit is divided into four sections:—

1.—Medicinal Chemicals.

2.—Laboratory Chemicals: (a) Pure chemicals for research purposes; (b) pure chemicals for analytical purposes; (c) indicators or hydrogen ion determination; (d) standard stains for microscopy.

3.—Pharmaceutical Products.

4.—Proprietary, Pharmaceutical and Toilet Specialities.

1.—*Pure Medicinal Chemicals*: In this section are exhibited many pure compounds for use in medicine. These include complex organic compounds prepared by synthetic methods and also active principles of natural origin derived from both plant and animal sources, as well as pure inorganic chemicals.

Medicinal Glucose.—The exhibit of pure medicinal glucose in this section is of particular interest.

Insulin.—Another very interesting feature in the work of the B.D.H. is the development of a department for the manufacture of biological products. Prominent in this department stands the manufacture of Insulin, the active principle of the pancreas which has already achieved such truly wonderful results in the treatment of diabetes. The discovery of Insulin constitutes one of the greatest romances of science. No other chapter in the history of medical progress, perhaps, records more painstaking research and indefatigable labour than that which led up to the discovery of insulin. Experiments having been carried out which proved that the disease of diabetes mellitus is caused by degeneration of certain tissue in the pancreas known as the "Islets of Langerhans," with resulting deficiency of their internal secretion, many attempts were made to isolate the active principle concerned with the object of utilising it in the treatment of diabetes. Finally, in 1922, a successful preparation containing these active principles was obtained by Drs. Banting and Best, working in the laboratories of the University of Toronto. The preparation having been discovered, a process was afterwards devised for practical purposes. This process, originated by Banting and Collip, resulted in the preparation Insulin, the active principle extracted from the normal pancreas, being introduced to the medical world.

(To be continued.)

GENERAL NOTES.

WHAT THE BUYERS FROM ABROAD WILL SEE AT THE BRITISH INDUSTRIES FAIR.

In the British Industries Fair, to be held at the White City, from April 28 to May 9, British manufacturers are finding new channels for a renaissance of home and export trade.

Replies to invitations from overseas buyers to attend have already created a record, and in view of the great influx of overseas visitors who will arrive in this country during the next few months, it can be confidently assumed that British trade will touch the highest point yet reached since the war.

Details of exhibits that will be on view at the Fair leave no doubt that never before has the resolutio nto obtain more trade by a study of foreign markets and their needs been more general throughout almost every industry. Not only is this a feature of the Fair, but it is obvious that British manufacturers, as a whole, realised the need for quoting the lowest possible prices for all lines consistent with unimpaired quality.

In the past, British quality has been sufficient to sell goods in the face of almost any competitive prices. The shortage of money since the war seriously impaired this asset. It is, therefore, doubly encouraging to note that British manufacturers as a whole have retained all their old quality, and are able to offer their goods at the coming Fair at prices which will compare favourably with those of almost any other foreign country.

In the section devoted to musical instru-

ments there will be two unusually interesting *instruments* which show that the gramophone is not all-conquering. One is a banjo bearing the signatures of all the members of the last Shackleton Antarctic Expedition with whom it went. The other, a banjo *signed* by H.R.H. the Prince of Wales, who took it on his recent tour through India.

The musical instrument section, representing an industry which has made great strides in this country during recent years, will be found to include very many examples of British enterprise, many of which form the subject of recent patents.

Brushes of whalebone, although by no means new, have been the subject of much skilful investigation by British manufacturers in search of improvements. Whalebone for commercial use is, of course, obtained from the jaws of the whale, where it serves as a fringe to catch a host of small fishes and sea animals, on which the whale lives. A single whale will yield from 800 to 2,000 lbs. of this bone from its jaws. The use of these bones as "bristles" has only been made possible by the invention of special machinery which cuts them into fine threads. Recent improvements have made such use increasingly popular owing to the flexibility and wear of the material. At the Fair the latest phases of the industry will be displayed.

Another material whose origin is not generally known is amber, in the use of which, as will be shown at the Fair, considerable strides have been made. It is a species of gum distilled from pines which have been dead for some hundreds of thousands of years. One very fertile source is the Baltic Sea, where in an incredibly remote period there grew trees which are today found only in tropical climates. It is estimated that amber has been gathered from that region for the last 3,000 years. Amber, much prized even as far back as the bronze-age, darkens with time, and will be found at the Fair in several varieties of new and novel designs.

It is not possible in a short article to do more than indicate briefly the numerous activities of British manufacturers who, by their foresight and enterprise, have made possible a new era in British export trade.

From indications already to hand the coming Fair will constitute a record for attendance and orders. Firms who, desirous of exhibiting, have not yet booked space, should communicate at once with the Secretary, the British Industries Fair, 35, Old Queen Street, Westminster, S.W.1, who will do everything possible to arrange accommodation. Allocation of space is already approaching the maximum, and no time should be lost if it is desired to take advantage of what is likely to prove a record Fair.

PROCEEDINGS AND NOTICES OF SOCIETIES.

THE ROYAL SOCIETY.

THURSDAY, MARCH 27.

Papers read:—

PROF. W. A. BONE, F.R.S., A. R. PEARSON and R. QUARENDON. *Researches on the Chemistry of Coal. Part III.—The Extraction of Coals by Benzene under Pressure.*

R. V. SOUTHWELL and SYLVIA W. SKAN. *On the Stability under Shearing Forces of a Flat Elastic Strip.* Communicated by Prof. G. I. Taylor, F.R.S.

J. E. P. WAGSTAFF. *Experiments on the Duration of Impacts, mainly of Bars with Rounded Ends, in Elucidation of the Elastic Theory.* Communicated by Sir Joseph Larmor, F.R.S.

Papers read in title only:—

N. AHMAD. *Absorption of Hard γ-Rays by Elements.* Communicated by Prof. Sir Ernest Rutherford, F.R.S.

E. V. EVANS and H. STANIER. *Sulphur Studies in Coal Gas. I.—The Removal of Carbon Bisulphide by a Nickel Catalyst.* Communicated by Prof. H. E. Armstrong, F.R.S.

THURSDAY, MARCH 20.

Papers read:—

SIR CHARLES SHERRINGTON, PRES. R.S., and E. G. T. LIDDELL. *Reflexes in Response to Stretch (Myotatic Reflexes).*

R. CAMPBELL THOMPSON, F.S.A. *The Plants of the Assyrian Medical Tablets.* Communicated by W. B. Hardy, Sec. R.S.

The present paper discusses the plants and trees of the Assyrian pharmacopœia as a whole (with a few unimportant exceptions) with their medical value, as well as many not used in medicine. It is hoped that some fifty new identifications of plants

have been made. The chief sources of information in cuneiform are (1) the medical tablets; (2) the botanical lists. The following table has been compiled from the author's "Assyrian Medical Texts":—

Drugs.	Approx. Species.	Approx. Occurrences
Vegetable	250	4,600
Mineral	120	650
Other, and unidentified	180	630
	550	5,880
Alcohols, various		490
Fats, oils, honey, wax, milk		660

Five channels lead to their identification: (1) Tabulation of the relative frequency of each plant in Assyrian medicine; (2) the different medical value of each; (3) philological comparison with other Semitic languages; (4) comparison with and limitation to the drugs of the ancient world; (5) the synonyms and comments in the Botanical Lists. (These latter, it should be remarked, indicate, in the main, an adherence to a regularity in the Assyrian arrangement of plants.)

Among the new plants believed to be identified may be mentioned *kukru*, fir-turpentine; *kasû*, rose; *sakhlu*, lolium; *khaldappânu*, mustard; *nukhurtu*, *tiyâtu*, asafœtida: *ASH*, a form of asafœtida (the original of the word *asa*), near *lasirbitu* (= laserpitium) in the lists; *Dilbat*, daisy; *nurmû*, pomegranate; *kamantu*, sumach; *azallû*, hemp; *qurban eqli*, chamomile; *nuçabu*, anemone; *shalluru*, medlar; *armanû*, apricot (the original of *Armeniaca*); *karshu*, cherry (the original of *cerasus*); *khassarratu*, *Euphorbia helioscopia*, L.; *musukkanu*, mulberry (the original of sycamine).

THE CHEMICAL SOCIETY.

ORDINARY SCIENTIFIC MEETING, MARCH 20.

Papers read:—

Rotatory Dispersion of Derivatives of Tartaric Acid. Part I.—Methylene Derivatives, by P. C. AUSTIN and V. A. CARPENTER.

Two compounds are obtained by the action of formaldehyde on tartaric acid. One is strongly dextro-, the other lævo-rotatory. These were prepared and examined in order to obtain further evidence of the nature of the dynamic isomerides which are present in aqueous solutions of d-tartaric acid of all concentrations (Lowry and Austin, *Phil. Trans. Roy. Soc.*, A. 1922, CCXXII., 240). Methylene tartaric acid was found to possess a specific rotation $[\alpha]_a^{20^\circ} = -81^\circ.3$ for solutions of different concentrations. Its rotatory dispersion is simple, and is expressed by one term of Drude's equation. Dimethylene tartrate, on the other hand, is strongly dextrorotatory, but its rotatory dispersion is also simple. Alternative formulæ are suggested for the latter compound. It is claimed that the complex character of the dispersion of tartaric acid is due to an oscillation of the molecule between two configurations, since this oscillation is prevented by bridging across the hydroxylic groups, when derivatives of simple dispersion result.

An interesting discussion followed, in which Prof. Lowry, Dr. Pickard, Prof. Baly, Mr. Hunter and Dr. Astbury took part.

The Rotatory Dispersive Power of Organic Compounds. Part XV.—The Molecular Weight of Ethyl Tartrate and the Origin of Anomalous Rotatory Dispersion in Tartaric Acid and its Derivatives, by T. M. LOWRY and J. O. CUTTER.

The cryoscopic constant of purified formamide, melting at 2.2° is 5.16° per gram mol. of urea in 1000 grams of solvent.

Purified ethyl tartrate is mono-molecular in this solvent up to a concentration of 16 per cent., the mean value of the cryoscopic constant being 5.18°. The dispersion curves for ethyl tartrate in this solvent are, however, strongly complex in character.

The molecular weight of ethyl tartrate in benzene increases to nearly double its normal value at a concentration of about 20 per cent. In this range of concentration the rotatory power of ethyl tartrate increases up to about 10 per cent., and then decreases again.

In ethylene bromide, the polymerisation of ethyl tartrate is more rapid than in benzene, but is accompanied by a progressive diminution of the lævorotatory power of the ester.

Ethyl tartrate gives even higher dextrorotations in naphthalene at 70° than in formamide at 20°; but it is more strongly polymerised (50 per cent. at 9 per cent. concentration) in this solvent at 80° than in benzene at the same temperature (Patterson).

These results are incompatible with Astbury's view that the dextrorotatory component of tartaric acid is a single molecule, whilst the lævorotatory component is a polymer in which the structure of the crystal is in part maintained.

The Heat of Adsorption of Oxygen by Charcoal, by E. A. BLENCH and W. E. GARNER.

The heat of adsorption of oxygen on a purified wood charcoal has been determined over a range of temperatures from 18° to 450°, and for varying degrees of saturation of the charcoal surface. The charcoal, suspended in a platinum gauze container, was heated to 900° for two hours in a high vacuum, cooled to the experimental temperature, a small quantity of oxygen was introduced into the space above the charcoal, and the rise in temperature was measured with a thermo-couple. The gaseous products, carbon monoxide and dioxide, were removed and analysed; the gas pressure above the charcoal was reduced to 10^{-3} mm., a further small volume of oxygen was then introduced, and the temperature was measured as before. A third admission of oxygen was sometimes carried out in a similar manner.

The heat of adsorption decreases as successive quantities of oxygen are adsorbed on the charcoal.

It is deduced that the heat of formation of stable groups of carbon and oxygen atoms on the surface increases with rise in the temperature of adsorption. This is in agreement with the experiments of Rhead and Wheeler on the thermal dissociation of the adsorption complex.

The Annual General Meeting was held on Thursday, March 27, at 4 p.m., when the President, Prof. W. P. Wynne, D.Sc., F.R.S., delivered his address.

THE GEOLOGICAL SOCIETY.

ANNUAL GENERAL MEETING.

February 15.—Prof. A. C. Seward, Sc.D., F.R.S., President, in the Chair.

The Reports having been received, the President presented the Wollaston Medal to Dr. Arthur Smith Woodward, F.R.S.; the Murchison Medal to Dr. Walcot Gibson; and the Lyell Medal to Mr. William Wickham King.

The President then presented the balance of the proceeds of the Wollaston Donation Fund to Dr. Cecil Edgar Tilley. The balance of the proceeds of the Murchison Geological Fund was then presented to Dr. Leonard Frank Spath by the President.

The President next presented the balance of the proceeds of the Lyell Geological Fund to Mr. John William Tutcher and to Mr. Hugh Hamshaw Thomas.

The ballot for the Council and officers was taken, and the following were declared duly elected for the ensuing year:—Council: Charles William Andrews, B.A., D.Sc.; F.R.S.; Frederick Noel Ashcroft, M.A., F.C.S.; Prof. Percy George Hamnall Boswell, O.B.E., D.Sc.; Prof. Arthur Hubert Cox, D.Sc., Ph.D.; Henry Dewey; James Archibald Douglas, M.A., D.Sc.; Gertrude Lilian Elles, M.B.E., D.Sc.; John William Evans, C.B.E., D.Sc., LL.B., F.R.S.; John Smith Flett, O.B.E., M.A., LL.D., D.Sc., M.B., F.R.S.; Sir Archibald Geikie, O.M., K.C.B., D.C.L., LL.D., Sc.D., F.R.S.; Frederick Henry Hatch, O.B.E., Ph.D.; Prof. Herbert Leader Hawkins, D.Sc.; Robert Stansfield Herries, M.A.; Sir Thomas Henry Holland, K.C.S.I., K.C.I.E., D.Sc., F.R.S.; William Dickson Lang, M.A., Sc.D.; Tressilian Charles Nicholas, O.B.E., M.A.; Prof. Sidney Hugh Reynolds, M.A., Sc.D.; Prof. Albert Charles Seward, Sc.D., F.R.S., F.L.S.; Walter Campbell Smith, M.C., M.A.; Leonard James Spencer, M.A., Sc.D.; Sir Aubrey Strahan, K.B.E., Sc.D., LL.D., F.R.S.; Prof. William Whitehead Watts, LL.D., Sc.D., M.Sc., F.R.S.; and Henry Woods, M.A., F.R.S.

Officers: — President: John William Evans, C.B.E., D.Sc., LL.B., F.R.S.; Vice-Presidents: Charles William Andrews, B.A., D.Sc., F.R.S.; John Smith Flett, O.B.E., M.A., LL.D., D.Sc., M.B., F.R.S.; Prof. Albert Charles Seward, Sc.D., F.R.S., F.L.S.; and Prof. William Whitehead Watts, LL.D., Sc.D., M.Sc., F.R.S.; Secretaries: Walter Campbell Smith, M.C., M.A., and James Archibald Douglas, M.A., D.Sc.; Foreign Secretary: Sir Archibald Geikie, O.M., K.C.B., D.C.L., LL.D., Sc.D., F.R.S.; and Treasurer: Robert Stansfield Herries, M.A.

The thanks of the Fellows were unanimously voted to Prof. A. C. Seward, retiring from the office of President; to Dr. J. W. Evans, retiring from the office of Vice-President; to Mr. R. D. Oldham and Dr. Herbert H. Thomas, retiring from the office of Vice-President and also from the Council; and to the other retiring Members of Council: Prof. W. S. Boulton, Prof. O. T. Jones, Mr. W. B. R. King, and Sir Jethro Teall.

FEBRUARY 27—PROF. W. W. WATTS, Sc.D., F.R.S., VICE-PRESIDENT, IN THE CHAIR.

The following communication was read and discussed:—

Age and Origin of the Lough Neagh Clays, by WILLIAM BOURKE WRIGHT, B.A., F.G.S.

MARCH 12.

The following communications were read:

Descriptions of Gasteropoda, chiefly in Mrs. Robert Gray's Collection, from the Ordovician and Lower Silurian of Girvan, by MRS. JANE LONGSTAFF (*née* Donald), F.L.S., F.G.S.

The Old Red Sandstone of the Cardiff District, by ALBERT HEARD, M.Sc., F.G.S., and R. DAVIES, M.Sc.

PHYSICAL SOCIETY OF LONDON.

MARCH 14.

Papers read:—

A New Photo-Electric and Ionisation Effect, by U. A. OSCHWALD, B.Sc., and A. G. TARRANT, B.Sc.

On Certain Properties of the Osglim Neon-Filled Lamp, by J. H. SHAXBY, B.Sc., and E. J. EVANS, B.Sc.

Notes on Some Electrical Properties of the Neon Lamp, by U. A. OSCHWALD, B.Sc., and A. G. TARRANT, B.Sc.

The Critical Resistance for Flashing, of the Low-Voltage Neon Discharge Tube, by J. TAYLOR, B.Sc., and W. CLARKSON, B.Sc.

Proceedings at the adjourned discussion on *Loud Speakers for Wireless and other Purposes*, held jointly with the Institution of Electrical Engineers on February 14, at the Institution of Electrical Engineers, C. C. Paterson, O.B.E., M.Inst.C.E., M.Inst.-E.E., in the chair.

The discussion was continued by Sir Richard Paget, Bart., Capt. B. S. Cohen, Mr. G. H. Nash, Capt. H. J. Round, Messrs. W. J. Brown, A. H. Davies, A. J. Aldridge, G. C. Marris, W. E. Burnand, Capt. N. Lea, Dr. H. M. Barlow and Mr. P. G. A. H. Voigt. Capt. Cohen and Mr. Voigt illustrated their remarks with demonstrations.

Proceedings at the meeting on February 22, F. E. Smith, C.B.E., F.R.S., in the chair:—

A Generalisation of Whitehead's Theory of Relativity, by G. TEMPLE, B.Sc., Birkbeck College.

The generalisation of Prof. Whitehead's theory of relativity appropriate to the case of a space-time manifold of uniform and isotropic curvature was given. The general equations of the gravitational and electromagnetic fields were obtained and applied to the discussion of the problems of planetary motion and of the deviation of light rays in the solar field.

The Structure of the Atomic Nucleus and the Mechanism of its Disintegration, by DR. HANS PETTERSSON, Göteborgs, Högskola, Sweden.

In interpreting the results of their experiments on the disintegration of certain light atoms by the impact of α particles, Rutherford and Chadwick have supposed that the α-particle transfers its momentum by direct impact to a proton which is a satellite to the rest of the nucleus. The author gave arguments for an alternative hypothesis which assumes that the α-particle exercises a trigger-action, precipitating an explosion of the nucleus which is supposed to have only a limited stability in the case of each of the elements.

The Effect of a Magnetic Field on the Surface Tension of a Liquid of High Susceptibility, by WINIFRED L. ROLTON, B.Sc., and R. STANLEY TROOP, B.Sc., East London College.

A method of measuring surface tension recently described by Dr. A. Ferguson has been applied to test solutions of ferric and manganese chlorides for the effect mentioned in the title. The results were negative.

THE INSTITUTE OF METALS.

ANNUAL GENERAL MEETING, MARCH 12 & 13.

Papers presented:—

The Relation between the Tensile Strength and the Electrical Resistivity of Commercially Pure Copper, by W. E. ALKINS, M.Sc.

An account was given of two short series of experiments carried out with the object of investigating the relationship which exists between the tensile strength of commercially pure copper as it is hardened by wiredrawing and the accompanying increase in its resistivity. Two samples of copper of high purity, from imported wirebars, were used. In the case of each sample a number of test lengths (tensile strength from about 16 to about 30 tons per square inch), were obtained by varying the method of preparation. The first series was drawn to and tested at 0.050 in., the second at 0.112 in. diameter; reasons were given for regarding the former as the more accurate. Resistance determinations were made on nominal one-thirtieth of a mile lengths, using a five-dial resistance box. The tem-

perature variation was kept as low as possible during the determinations. Both tensile strength and resistivity values were corrected to standard weight.

The results show that the relation between the tensile strength and the percentage increase of the resistivity, as compared with the annealed wire, is reasonably rectilinear when the tensile strength exceeds 20 tons per square inch, and it is suggested that the resistance (R_t) of any given wire of tensile strength T tons per square inch should be taken as:—

$$R_t = R_s \frac{100 + \frac{T}{10}}{100}$$

where R_s = the resistance of a similar annealed wire corresponding to the international standard.

The Brittle Ranges in Brass as Shown by the Izod Impact Test, by D. BUNTING, M.Sc.

It has long been known that certain brass alloys are brittle at high temperatures. As these alloys are worked and sometimes put in use at temperatures in the neighbourhood of that at which brittleness occurs, it is of importance that this fact should be investigated.

The method employed of testing for brittleness was the Izod impact test. A series of alloys varying in composition from 99 per cent. copper to 52 per cent. copper were tested at temperatures between 15° C. and 700° C. The results were incorporated in a diagram, of which the co-ordinates were temperature, the abscissæ were percentage of copper, and the vertical component was the Izod figure. Contours were drawn at intervals of 5 ft.-lb., and showed the brittle ranges.

Brittleness occurs in all brasses containing less than 90 per cent. of copper, being first encountered in 90:10 brass, in which the brittle range exists from 470° C. to 540° C. With increase of zinc the range expands, and in the case of a 70:30 brass occurs between 325° C. and 800° C. At a composition of 65 per cent. copper the range extends from 325° C. until the solidus is entered. The $\alpha + \beta$ alloys are found to possess a recovery of toughness at high temperatures. The brittle range of the 58:42 alloy extends from 325° C. to 450° C., above which temperature the recovery of toughness occurs; any further increase of temperature causes the plasticity of the metal to become more pronounced. These alloys comprise those employed for hot-stamping, hot-rolling and similar work.

The alloys were examined in two conditions, chill cast and annealed, and it was found that with the rapidly cooled alloys there was a general increase in the brittle ranges, due in the case of α alloys to coring, and in the case of $\alpha + \beta$ alloys to the production of increased quantities of β.

The brittle ranges are believed to be due to the thermal inversion occurring in B at a temperature in the neighbourhood of 470° C.; it is also probable that a similar thermal change occurs in α brasses, this being responsible for the brittleness of α alloys.

The Cadmium-Lead-Zinc System, by MAURICE COOK, M.Sc., PH.D.

Data concerning the three binary systems involved in the investigation have been collected, and diagrams based on these data were given. The ternary system has been investigated thermally and microscopically. The freezing points and other thermal arrests for ninety-six different alloys are given. Near to the cadmium-lead binary eutectic is a ternary eutectic containing 81.7 per cent. lead. 17.3 per cent. cadmium and 1 per cent. zinc, which freezes at 245° C. There is a large zone in which the metals are not completely miscible in the liquid state. This occupies most of the area between the zinc corner and the lines joining the ternary eutectic to the lead-zinc and cadmium-zinc eutectics.

The critical curve is not symmetrical and the tie lines are not parallel to the lead-zinc base, but diverge progressively from the parallel position with increasing cadmium content. These facts indicate that the concentrations of cadmium in the two liquid layers are not identical. It is not until more than 65 per cent. of cadmium has been added that a mixture of equal weights of lead and zinc yields a homogeneous liquid phase. The limits of the region of partial miscibility have been determined microscopically as well as from considerations of the liquidus isothermals. Vertical sections of whole ingots have been made to ascertain the presence or absence of two layers. Photomicrographs and whole section photographs (natural size) were given.

The Relative Corrosion of Zinc and Lead in Solutions of Inorganic Salts, by J. NEWTON FRIEND, D.Sc., PH.D., F.I.C., and J. S. TIDMUS, B.Sc.

The authors have studied the rates of corrosion of zinc and lead when immersed in varying concentration of different inor-

ganic salt solutions. The results are found to closely resemble those obtained with iron under similar conditions, and the explanation appears to be substantially the same.

Determination of the Thermal Coefficients of Expansion of Some Commercial Metals and Alloys, by J. NEWTON FRIEND, D.Sc., PH.D., F.I.C., and R. H. VALLANCE, M.Sc.

A simple form of apparatus was described whereby the coefficient of expansion of a metal bar with rise of temperature can be rapidly determined with an accuracy of about one per cent.

Copper-Zinc Alloys which Expand on Solidification, by K. IOKIBE, M.Sc.

The remarkable expansion which takes place when certain copper zinc alloys are slowly cooled, first observed by Turner and Murray, has been re-examined. Extensometer tests show that the expansion is observed only with alloys containing from 5 per cent. to 30 per cent. of copper. There is a sharp maximum peak with 15 per cent. of copper. The alloys, if very quickly cooled from the molten state, have a density which is slightly higher than that calculated on the assumption of no volume change; in other words, there is a contraction on alloying. The amount of expansion varies with the rate of cooling; with very slow cooling the density may fall from 7.3 to 6.2, corresponding with an expansion of about 18 per cent. The force of the expansion is sufficient to break the crucibles in which the alloys are allowed to solidify. The increase of bulk is due to the formation of minute voids, which are not gas holes. When compressed, the alloys increase in density: drillings or turnings give values practically identical with those obtained by very rapid cooling. Slowly cooled alloys are of uniform composition throughout, but chill cast bars, though of uniform average composition when examined in horizontal sections, are inversely segregated vertically. Rapid cooling leads to a concentration of copper, the less fusible metals towards the centre of the bar. The more rapid the cooling, the greater is the difference in copper content between successive vertical layers on proceeding from the outside to the inside of the bar. The difference may amount to as much as 25 per cent. of the total copper content. The maximum inverse segregation in rapidly cooled alloys coincides with the maximum expansion of slowly cooled alloys. Chill cast alloys, on annealing, expand, while the copper content tends to become uniform throughout. In the range of considerable expansion and of inverse segregation, there is no definite microstructure: separate constituents are no longer clearly recognisable, but all is blurred and confused. The expansion appears to be connected with the change, on slow cooling or annealing, from the unstable state of inverse segregation to the stable state of uniform composition.

THE MINERALOGICAL SOCIETY.

At the meeting on March 18 the following papers were read:—

DR. L. J. SPENCER, *Allopalladium from British Guiana*.

W. CAMPBELL SMITH, *On a Serpentine-like Mineral from Burgenland, Austria*.

H. C. G. VINCENT, *Chemical Analyses of Granite from Dufton, Westmorland, and of Mica from Burma*.

THE ROYAL SOCIETY OF ARTS.

On March 19, at the Ordinary Meeting, a lecture entitled *The Forests and Timber Supply of North America* was delivered by R. L. ROBINSON, ESQ., Forestry Commissioner. The Right Hon. Lord Clinton, Forestry Commissioner, presided.

On Friday, March 21, at a meeting of the Indian Section, a lecture entitled *Progress of Co-operative Banking in India*, was given by OTTO ROTHFELD, I.C.S. (Bombay). The Right Hon. Lord Lamington, G.C.M.G., G.C.I.E., presided.

On Monday, March 24, the first Cobb Lecture, entitled *Certain Fundamental Problems in Photography*, was delivered by T. SLATER PRICE, D.Sc., PH.D., F.I.C., Director of Research, British Photographic Research Association.

On Wednesday, March 26, at the Ordinary Meeting, a paper entitled *The Fishing Industry and its By-Products* was delivered by NEAL GREEN, ESQ. Prof. E. W. Macbride, Esq., D.Sc., LL.D., F.R.S., presided.

THE ROYAL INSTITUTION OF GREAT BRITAIN.

The Friday evening discourse on March 21 was delivered by SIR FREDERICK KEEBLE, F.R.S., on *The Plant Commonwealth and its Government*.

On Saturday, March 22, at 3 p.m., SIR ERNEST RUTHERFORD, F.R.S., will give his third lecture on *Properties of Gases in High and Low Vacua*.

THE INSTITUTION OF ELECTRICAL ENGINEERS.

At the Ordinary meeting on March 20, a lecture on *The Nature and Reproduction of Speech Sounds (vowels)* was given by SIR RICHARD PAGET, BART.

THE INSTITUTE OF PHYSICS.

At the last meeting of the Board the following Corporate Members were elected: *Fellows*—B. W. Clack, T. F. Connolly, W. Jevons, A. L. McAulay, E. T. Paris; *Associates*—S. G. Barker, F. Charnley, W. E. Dickes, A. E. Evans, F. G. Strawley.

ROYAL AGRICULTURAL SOCIETY OF ENGLAND.

At the Monthly Council, held on March 5, Mr. Ernest Mathews, C.V.O. (President) in the chair, the Chemical Report was presented, together with others.

CHEMICAL.

Lord Bledisloe, in the absence of Mr. J. L. Luddington, reported that the Consulting Chemist had submitted a list of samples analysed by him for members during the past month. He had reported to the Committee that he was having great difficulty in getting two members of the Society to settle their accounts for analyses made some time ago, and the Committee recommended that the matter be left in the hands of the Secretary, for him to take the usual steps in dealing with such matters.

Dr. Voelcker had reported that March 11 had been fixed for the final meeting of the Departmental Committee on the Fertilisers and Feeding Stuffs Act and the signing of the report.

The revival of the issue to members of "Occasional Notes," suggested by Dr. Voelcker, had been referred for consideration to the Research Committee.

Dr. Voelcker had reported to the Committee regarding various matters arising out of his correspondence.

Mr. Middleton said that the Chemical Committee proposed that the issue of "Occasional Notes" from the various scientific departments of the Society, suspended for reasons of economy, should be revived. It had been found that there was a growing desire on the part of members in different parts of the country that these "Notes" should be reissued.

Lord Bledisloe stated that this was a matter which would come up on the report of the Rese[illegible]

THE ROYAL INSTITUTION.

On Tuesday, March 25, Prof. G. GORDO[N] began a course of three lectures at the Roya[l] Institution on *Ballads*, and on Thursday March 20, Prof. D. S. M. WATSON delivere[d] the first of two lectures on *Evolution To-day* The Friday evening discourse on March 2[8] will be delivered by DR. HUGH MACLEAN, o[n] *Insulin*, and on April 4 by SIR ERNES[T] RUTHERFORD, on *The Nucleus of the Atom*.

THE INSTITUTION OF ELECTRICAL ENGINEERS.

A Wireless Section meeting will be hel[d] on April 2. A paper, entitled *Thermioni[c] Valves with Dull-Emitting Filaments*, b[y] the Research Staff of the General Electri[c] Co., Ltd., will be read. (The work will b[e] carried out by Messrs. M. Thompson and A C. Bartlett.)

An Ordinary Meeting was held on Marc[h] 27, when a paper entitled *The Future o[f] Main Line Electrification on British Rail ways* was read by LT.-COL. H. E. O'BRIEN D.S.O. (Member).

THE INSTITUTION OF MINING AND METALLURGY.

The Sixth Ordinary General Meeting o[f] the Thirty-Third Session of the Institutio[n] of Mining and Metallurgy was held at th[e] rooms of the Geological Society, Burlingto[n] House, Piccadilly, London, W.1, on Marc[h] 20. The following papers were submitte[d] and discussed:—

The Manufacture of Zinc and Zinc-Lea[d] Oxide from the Complex Ores, by R. G HALL.

The Shamva Mines, Rhodesia, by CYRI[L] E. PARSONS, Member.

Field Methods in Sedimentary Petrography, by G. M. FLEMING.

THE SOCIETY OF GLASS TECHNOLOGY.

A meeting of the Society of Glass Technology was held in St. Thomas' Hall, Stourbridge, on March 19. The following papers were read and discussed:—

The Properties of Lead-Containing Glasses, by PROF. W. E. S. TURNER, D.Sc.

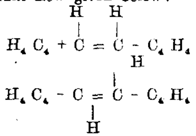
The Art of British Glass Decorators—Th[e] Duplication of the Portland Vase, by JOHN [illegible]

CORRESPONDENCE.

THE ISOMERIDES OF NAPHTHALENE.

To the Editors of THE CHEMICAL NEWS.

SIRS,—Naphthalene, by its physical properties, has been shown to exist in two allotropic forms. These may be represented by the formulæ now given below:—



These formulæ indicate possible stereoisomerism remaining to be discovered.—Yours, &c., J. C. THOMLINSON, B.Sc.

NOTICES OF BOOKS.

The Chemical Manufacturer's Directory of England, Wales and Scotland. Pp. 225. Fifty-sixth Edn., 1924. Messrs. Simpkin, Marshall, Hamilton, Kent & Co., Paternoster Row, E.C.4. 4s. 6d. net.

This useful directory has been published uninterruptedly for over fifty years, and continues to be a most valuable guide for the chemical industry. In one section chemicals are classified, indicating the makers of each substance, and then there are sections giving the lists of manufacturers (alphabetically) of England, Wales, Scotland and Ireland.

Watson's Microscopical Record, No. 1, February, 1924. Pp. 16. Text illus. W. Watson & Sons, Ltd., London. Free on request.

This is the first number of a periodical to deal with matters microscopical. Similar journals have previously enjoyed an ephemeral existence, and it is to be hoped that the present one will not suffer a like fate. The purpose of the new "Record" is to supply details of new processes and improved instruments to those workers cut off from societies. Readers are invited to send suggestions for making the "Record" useful, and to send articles on microscopical work. The present number contains articles on Current Microscopy; Critical Observational Methods in efficient Bacteriological Microscopy; A Fascinating Sea Shore Study; and a number of Notes and Queries.

Messrs. Watson & Sons are to be congratulated on their new enterprise. It is possible to make the "Record" extremely valuable, and it is hoped such will be the case. E.H.E.

BOOKS RECEIVED.

Technische Fortschrittsberichte, Fortschritte der Chem. Technologie in Einzeldarstellungen, by PROF. DR. B. RASSOW. Pp. VIII. + 79. 1924. Verlag von Theodor Steinkopff, Dresden und Leipzig, Germany.

Handbuch der Spectroscopie, von H. KAYSER und H. KONEN. Pp. X. + 498. 1924. Verlag von S. Hirzel, Leipzig, Germany. 80 marks.

Messrs. W. & G. Foyle have issued their 1924 *Catalogue of Technical and Scientific Books.* It occupies over forty pages, and includes books on all branches of science and technology.

Laboratory Experiments in Chemistry, by N. HENRY BLACK. Pp. IX. + 165. 1923. 1st Ed. Messrs. Macmillan & Co., Ltd., St. Martin's Street, W.C.2. 5s. net.

The Chemical Manufacturer's Directory of England, Wales and Scotland. Pp. 225. 56th Ed., 1924. Messrs. Simpkin, Marshall, Hamilton, Kent & Co., Paternoster Row, E.C.4. 4s. 6d. net.

Technical Methods of Chemical Analysis, by CHARLES A. KEANE, D.Sc., PH.D., and P. C. L. THORNE, M.A., M.Sc. Pp. XX. + 704. Second Edition, Vol. 1, 1924. Messrs. Gurney & Jackson, 33, Paternoster Row, E.C.4. £3 3s.

Abridged Scientific Publications from the Research Labgratory of the Eastman Kodak Company. Pp. 287. Vol. VI., 1922. Eastman Kodak Company, Rochester, New York.

Tested Methods of Mineral Analysis, by B. T. KITTO. Pp. 125. 1924. Messrs. H. F. & G. Witherby, 326, High Holborn, W.C. 7s. 6d. net.

PUBLICATIONS RECEIVED.

The British Cast Iron Research Association has just issued its Second *Annual Report*, 1923. The progress made during the year and a list of the members is given.

The Department of the Interior, United States Geological Survey, has issued the following bulletins:—

Geology of the Tullock Creek Coal Field, Rosebud and Big Horn Counties, Montana, by G. SHERBOURNE ROGERS and WALLACE LEE. Pp. VI. + 181.

Pedestal Rocks in the Arid Southwest, by KIRK BRYAN. Pp. 11.

Surface Water Supply of the United States, 1919 *and* 1920. *Part* II.—*South Atlantic Slope and Eastern Gulf of Mexico Basins*, by NATHAN C. GROVER. Pp. 80.

Surface Water Supply of the United States, 1919 *and* 1920. *Part* V.—*Hudson Bay and Upper Mississippi River Basins*, by NATHAN C. GROVER. Pp. V. + 287.

Variation in Annual Run-Off in the Rocky Mountain Region, by ROBERT FOLLANSBEE. Pp. 14.

Surface Water Supply of the United States, 1921. *Part IV.—St. Lawrence River Basin*, by NATHAN C. GROVER. Pp. IV. + 112.

Surface Water Supply of the United States, 1921. *Part VIII.—Western Gulf of Mexico Basins*, by NATHAN C. GROVER. Pp. IV. + 96.

New Patents.

THIS list is specially compiled for *The Chemical News* by Messrs. Rayner & Co., Registered Patent Agents, of 5, Chancery Lane, London, from whom all information relating to Patents, Trade Marks, and Designs can be obtained gratuitously.

Latest Patent Applications.

5908—Millar, W. S.—Desulphurisation and concentration of sulphide iron ores. March 7.

5710—Adelantado, L.—Manufacture of phosphate fertiliser. March 5.

Specifications Published this Week.

21'536—Moxham, A. J.—Treatment of silicious metal-bearing minerals.

211599—Pickford, J. E.—Recovery of volatile liquids, solvents, and the like.

211772—Chemische Fabrik Griesheim Elektron.—Manufacture of acylacetyl compounds.

211791—Henkel et Cie, and Weber, Dr. W.—Treatment of ammonium chloride lyes in iron vessels.

Abstract Published this Week.

210033—Titanium sulphate.—Weizmann, C., Blumenfeld, J., 16, Addison Crescent, London.

A crystalloidal solution of titanyl sulphate is obtained by treating a titaniferous material such as ilmenite with sulphuric acid in the proportion of 1 part of TiO to 1.2 to 1.8 parts sulphuric acid. The concentration should be such that the boiling-point is above 130° C., but is kept below the rising boiling-point, and is gradually increased to at least 140° C., and may reach 250° C. The reaction product is treated with a limited quantity of water to obtain the solution.

Messrs. Rayner & Co. will obtain printed copies of the published specifications and abstract only, and forward on post free for the price of 1s. 6d. each.

NOTICES.

EDITORIAL.—All Scientific and Technical communications for publication, and also all Books, Chemical Apparatus, &c., for Review or Notice to be addressed to the EDITORS.

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THE CHEMICAL NEWS,

VOL. CXXVIII. No. 3338.

THE CHEMISTRY OF POLYCYCLIC STRUCTURES IN RELATION TO THEIR HOMOCYCLIC UNSATURATED ISOMERIDES.

PART I.—DERIVATIVES OF CYCLO PENTENE AND DICYCLOPENTANE.

BY R. F. HUNTER, F.C.S.

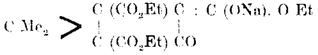
Preliminary Note:

In this series of papers, of which this forms the first part, it is intended to discuss in some detail the investigations which have been carried out in our laboratories at the Royal College of Science. It is not intended to discuss the criticism which has been levelled against certain of the theoretical considerations, such as the mutarotation of the sugars in relation to ring chain tautomerism, etc., mainly by Professors Lowry and Armstrong, but it is hoped to dispel to a certain extent the idea which appears to be vogue with a number of organic chemists as regards the school of Thorpe and Ingold, namely, that the attitude of this school as regards the theories of organic chemistry is that we know no more than that the carbon atom is tetrahedral in nature.

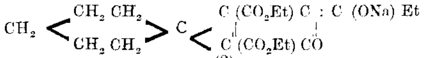
was undertaken under the direction of Pro-

Perkin and Thorpe (*J.C.S.*, 1901) showed that when ethyl αα′ dibromo ββ dimethylglutarate is condensed with ethyl malonate in the presence of sodium ethoxide in large quantities, there is formed a yellow sodium compound, to which the structure (1) has been assigned. A number of derivatives of this sodium compound were prepared by alkylation and subsequent hydrolysis, and many of the compounds so obtained were subjected both to oxidation and reduction.

In a more recent paper on the stability of spiro compounds (*J.C.S.*, 1919) a similar compound was prepared from ethyl αα′ dibromocyclo hexane 1 : 1 diacetate of the structure (2).



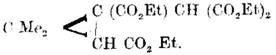
(1)



(2)

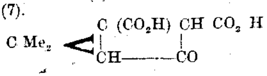
This also yielded a series of products of hydrolysis, etc., more or less analogous to the gem dimethyl compound (1).

In the course of these investigations no fact was discovered which truly could be regarded as throwing doubt on the structures assigned to the compounds and their more immediate derivatives, that is to say, which throws doubt on the bridge formula above. In fact the evidence was of a positive nature as regards the formulation as bridged derivatives, and a considerable amount of evidence has been collected in this way which is, of course, mainly concerned with the mode of formation of the sodium compounds. Thus, when ethyl αα dibromo ββ dimethylglutarate is treated with ethyl sodiomalonate in the proportions of one to two, there is formed the sodium compound of the ester, which clearly must have the constitution (3). This, on treatment with sodium in xylene, loses a molecule of alcohol, being converted into the yellow sodium compound (1).

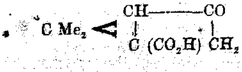


(3)

Toivonen recently cast doubt on the structures assigned to the bridged compounds in this way (*Annalen*, 1919, CCCCXIX., 176), when the sodium compound is hydrolysed by acids it yields first the dibasic acid (6) and then the monobasic acid (7).

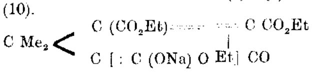


(6)

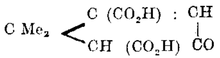


(7)

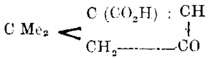
Now during his work on the oxidation of isodehydrofenchoic acid, Toivonen obtained the monobasic acid as product of oxidation. He then stated that in view of this he considered not only the acid, but all the compounds of the series, were unsaturated substances containing the cyclopentene and not the dicyclopentane ring system, and that the formulæ of the three compounds discussed above were therefore (8), (9), and (10).



(8)



(9)



(10)

He also made the observation that the ›xidation of isodehydroenchoic acid by alkaine potassium permanganate proceeds in :wo stages, the first product of oxidation ›eing a diketonic acid (11), which under;oes internal condensation under the inluence of alkali to give Perkin and Thorpe's ıcid with the elimination of a molecule of vater. We have, then, it is clear, two nethods of formation of one substance vhich are extremely difficult to reconcile vith one another. In fact, one must asume that either the conversion of the ester 8) into the yellow sodium compound, intead of being, as one would suppose, a imple Dieckmann condensation, is a some·hat peculiar change involving the rupture y alcoholysis of the cyclopropane ring, or egard the internal condensation of the dietonic acid (2) as taking place in two tages, the first of which involves the forıation of a cyclic aldol condensation prouct which dehydrates across the cyclopenıne ring, both explanations are equally ex·aordinary.

The work of Ingold and Farmer clearly ıowed once and for all that the series of ›mpounds discussed above possess the ridge structure and not the unsaturated ıe of Toivonen in the following way. onsider the dibasic acid, the bridge formula of which is (6) and the double bond formula of which is (9). Now an acid of the formula (9) can be shown by the aid of the conventional space models to be an acid, in which the carboxyl groups are further apart than in such compounds as trans hexahydroisophthalic acid and cis hexa hydroterephthalic acid, and therefore one could not expect the acid to form an anhydride, while it does so actually with the greatest ease in accordance with the bridged formula (6).

The next point arises in connection with the methylation of the yellow sodium compound by means of methyl iodide, on treatment of which with alcoholic potash there is formed the lactone of a hydroxy tribasic acid, the production of which clearly involves, firstly, the hydrolysis of the three carbethoxyl groups to carboxyl; next, the loss of a carboxyl as a molecule of carbon dioxide; thirdly, fission with the addition of water in the immediate neighbourhood of the ketonic group, which thus becomes carboxyl; and lastly, a further fission with water addition. No matter what formula one adopts for the lactone, the first process can only take place in one way, the second in two ways, and the third in two ways.

Further, if one assumes a bridge structure for the lactone, the addition of a further molecule of water, the last process of necessity involves the fission of one of the cyclopropane bonds. This can take place in six ways. On the other hand, if the unsaturated structure is assigned to the lactone, the addition must take place at the unsaturated part of the molecule, namely, the double bond, and this, of course, can only take place in two ways. Considering the combination of the possibilities, one sees that as many lead to the same formula there are but six possible formulæ for the tribasic acid derived from the bridge ester and six from the unsaturated ester. The properties of the lactone show clearly that in the corresponding hydroxy acid, the hydroxyl is in the gamma position with respect to one of the three carboxyl groups, that no two carboxyl groups are attached to the same carbon atom, and that the two carboxyls which are not in the gamma position are attached to two carbon atoms directly united. This reduces the number of formulæ to three, one of which is the accepted one from the bridge compound, whereas the formulæ for the compound are reduced to one. With regard to the unsaturated form, this differs from the customary formula (12), only as re-

gards the position of the methyl group, since it has the formula (11)

$$C\,Me_2 < \begin{matrix} C\,(CO_2H).CH_2.CO_2H \\ CH\,Me.CO\,O \end{matrix}$$

(11)

$$C\,Me_2 < \begin{matrix} C\,(CO_2H).\,CH\,Me.\,CO_2H \\ CH_2.CO\,O \end{matrix}$$

(12)

This difference, however, is important because the lactonic acid was found by Ingold and Farmer to exist in two forms, namely, cis and trans, each of which yielded its own anhydride. This is fulfilled by the formula (12), but not by (11). Clearly, then, the structures are of the bridge type, as first enunciated by Thorpe and Perkin.

Toivenon, however, was more deeply impressed by the behaviour of the monobasic acid on permanganate oxidation. It was shown by Perkin and Thorpe that when the acid is treated with alkaline permanganate it is converted into an dihydroxy $\beta\beta$ dimethylglutaric acid. Toivenon saw that the oxidation is easily explained along the conventional lines if one asumes the unsaturated formula for the monobasic acid, in practice four to five atoms of oxygen being taken up and the products being as dimethylsuccinic acid and dihydro xydimethylglutaric acid. In spite of this apparently simple scheme (*J.C.S.*, 1920, 1367) the issue is not so clear, because Ingold and Thorpe have shown that the bridge bond in such dicyclopentane systems is in a condition of very great strain, and may become the most unstable part of the molecule giving rise to reactions which are very similar to those exhibited by unsaturation. This strain originates from the fact that both rings to which the bridge bond is common have internal angles considerably smaller than the normal angle at which two valencies are inclined as regards carbon to carbon. There is then a mutual accommodation existing between the strains which react on the carbon atoms terminating the bridge, rendering the latter stable to a considerable degree. The theory can be put on a quantitative basis by a simple calculation (*J.C.S.*, 1920); therefore the argument that because dimethyldicyclo heptanone can be oxidised to a cyclopropane derivative caronic acid the acids from dimethyldicyclopentanone should behave similarly on similar oxidation is unconvincing.

When the dibasic acid was titrated with permanganate in alkaline solution, a sharp end-point was found corresponding to the absorption of three oxygen atoms according to

$$C_9H_{10}O_5+3O+2H_2O = C_7H_{12}O_6+C_2H_2O_4.$$

The production of oxalic acid is a further proof of the bridge structure of these compounds. When care was taken the formation of dimethylsuccinic acid was avoided, oxalic and dihydroxydimethyl glutaric acids being formed quantitatively.

Now it is clear at this point that if caronic acid could be obtained as a product of oxidation of the dibasic acid, we should have the clearest proof of the dicyclic constitution of these substances. The difficulty is, of course, to find a substance which can oxidise the four-membered ring at the carbonyl and yet leave the bridge intact. This reagent was found in hydrogen peroxide and potassium ferricyanide, and affords the final proof of the bridge structure of these compounds.

February, 1924.

British Empire Exhibition.

PARTICULARS OF EXHIBITS.

(*Continued from Page* 199.)

THE BRITISH DRUG HOUSES—(*Continued*).

The manufacture of Insulin was undertaken by the British Drug Houses, Ltd., in association for this purpose with Messrs. Allen & Hanburys, Ltd., of Bethnal Green, London, in the beginning of 1923, under licence granted to the two firms jointly by the Medical Research Council. The Canadian discoverers had previously granted a patent for the manufacture of Insulin to an American firm, who had thus obtained a six months' start over the British manufacturers. The B.D.H. erected new buildings and devised and installed special plant. Working at high pressure, work being continuous, day and night throughout weekends, the staff of highly skilled workers specially trained for this purpose, ably backed by the firm's staff of skilled engineers, quickly overcame the exceedingly great technical difficulties incidental to the manufacture of this fugitive substance; and in an incredibly short space of time, namely, less than three months, the B.D.H.

achieved the production of Insulin on the large industrial scale, and succeeded in placing Insulin on the market.

If the discovery of Insulin constitutes a romance of science, the achievement by the B.D.H. of the manufacture of Insulin on the large industrial scale in the circumstances described may justly be called a romance of industry.

2.—*Laboratory Chemicals*: Before the war we had been dependent upon Germany for supplies of laboratory chemicals. Finding supplies cut off at the beginning of the war, a committee was appointed jointly by the Institute of Chemistry and the Society of Public Analysts, which drew up standard specifications of purity for analytical reagents. The B.D.H. stepped into the breach, and undertook the manufacture of these and other laboratory chemicals. A special department for their production was opened up, and development has since been prosecuted assiduously and continuously.

The remarkable enterprise of this firm has now resulted in their list of chemicals numbering upwards of 3,500; and this industry affords a training ground for chemists and gives employment to numbers of chemists, chemical workers, and other classes of labour.

Stains and Dyes for Microscopic Purposes.—In this section are also shown a range of standard stains and dyes, a supply of which is essential for microscopic work. Before the war these were exclusively of German origin.

B.D.H. Universal Indicator is the most useful reagent for determining quickly the approximate P_h of a fluid. The Universal Indicator is a mixture of several indicators, and shows the whole range of spectrum colours from red to violet in the correct order. It is used by adding 0.1 cc. of the indicator to 10 cc. of the liquid under examination, when the colour produced will indicate the approximate P_h. It is particularly valuable for the control of manufacturing operations.

3.—*Pharmaceutical Preparations*: In this section of the exhibit will be found representative products illustrative of the many classes of pharmaceutical preparations, known in pharmacy as "galenicals," which are manufactured in the B.D.H. laboratories. These include solid and liquid extracts, tinctures, medicinal liquors and essences, syrups, emulsions, confections, granular effervescent preparations, ointments, pills and compressed tablets, lozenges, gelatine capsules, ampoules and semipules.

4. — *Proprietary, Pharmaceutical and Toilet Specialities*: The number of proprietaries manufactured by the company is large and only the chief lines are being exhibited.

All the products packed are actually manufactured by the company, and only material of B.D.H. quality—*i.e.*, the best—is employed.

Eastern Foam.—Special mention must be made of Eastern Foam. The name of this vanishing cream is a household word in this country, where its sales are probably larger than those of any other preparations of the kind, and are rapidly being extended in overseas markets.

The reasons for its popularity are: (1) The charm of the cream itself—Eastern Foam is a delightful non-greasy foam, with an alluring and exclusive oriental perfume. The cream, which contains no glycerine, "vanishes" immediately it is applied, and does not dry the skin. (2) The striking appearance of the package. The pot is specially designed, with glass lid and washer to prevent deterioration. The colours of the carton make a distinctive and appealing display, which is enhanced by the accompanying show material supplied to retailers. (3) The character and extent of the advertising. In addition to widespread press publicity, Eastern Foam is advertised on vehicles; by means of flash signs in chemists' windows; by the exhibition of glass strips and mirrors in public places; by the constant distribution of samples; the professional dressing of chemists' windows, and in numerous other ways.

Introduced only in 1916, Eastern Foam has thus shown a truly remarkable development, and it is noteworthy that periods of general bad trade have never been reflected in its sales, which have steadily increased each year. As an example, the sales in 1923 amounted to nearly ten times those of 1917.

Eastern Foam is manufactured and packed on "mass production" lines, the system being as follows:—

The cream is stored under pressure in reservoirs, whence pipes are carried under the floor to the packing table, which runs the length of the room. In the centre of the table, and flush with the surface level, is a slowly moving canvas belt, and on each side is a row of expert girl workers, each performing a necessary part of the packing.

First on each side is a girl operating a ›ecial machine which fills the pots at the .te of 30 per minute. As the pots are filled ıey are placed on the moving belt, and so ırried to the next girls, who fit on the glass ses and caps. The next put on the labels ıd so on, until at the extreme end of the :nch the finished article (sealed outers of 3 ›zen jars) is taken off, all ready for desıtch to the trade. The whole journey ıwn the table is a matter of a few minutes.

Similarly, the popular little sample boxes e being dealt with in a similar way. The ıtput of these is 60-70 gross per diem, and at of the pots 35-40 gross per diem, alough, of course, more workers can be put ı, should a special "rush" be necessary. ıe constant practice of one special operaın naturally makes each girl wonderfully pert and quick in her particular part.

It will be realised from this brief descripın that every possible device to speed up oduction is employed. Only thus can the sistent demands of the trade be met.

ᴜRGOYNE, BURBIDGES & Co., LTD.

The outstanding features of this exhibit e medicinal chemicals and pharmaceutil preparations. Attention is directed to e production of organic medicinal chemils, especially chloral hydrate, of which the ın are the largest English makers. A heme is exhibited showing its method of oduction.

Among specimens, typical of the whole nge of medicinal chemicals, are sodium licylate, menthyl valerate, camphor monoomide, chloramine T., benzoates and ciıtes, while a nuber of scale preparations e also on view.

Fine chemicals are represented by speciens of acids, aldehydes, alcohols, ketones, .hydrides, nitriles and amines. These pro.cts are of a high standard, and the actual iling ranges and melting points are on the bels and indicate the standards below ıich the products do not fall.

Pharmaceutical preparations include nuerous examples of tinctures, liquid exıcts, syrups, and other galenicals which ntain the active medicinal ingredients of ude drugs in a form ready for the dispens- g of medicines.

Pills, compressed tablets, ampoules, caples and suppositories form another subction, these products being noted for their curacy of dosage.

Stains and reagents prepared from pure estuffs for bacteriological and other work e also shown, together with a complete ıge of analytical reagents.

Perfumery and flavouring substances are represented by ethyl and amyl esters, valerates, cinnamates and butyrates.

Soluble essences for aerated waters, confectionery, and other purposes, together with extra concentrated fruit ottos which accurately reproduce, when diluted, the flavour of the fresh fruit, and floral ottos for the immediate production of the finest fragrant perfumes, will also be exhibited.

BURT, BOULTON & HAYWOOD, LTD.

The exhibit largely consists of the products manufactured in all the English tar works of the firm. Together with the samples of various wood preservatives are shown specimens of timber which have been creosoted and exposed to the atmosphere for over 70 years, demonstrating as they do the wonderful efficacy of creosote as a wood preserver.

Over 60 years' experience in the treatment and preservation of timber has shown that there is no process so satisfactory as that of creosoting.

All types of disinfectants are exhibited, and certain quite new horticultural products are also shown. A new product of exceptional interest is that of colloidal sulphur, now manufactured at the company's works at Silvertown. This sulphur is prepared in an extraordinary fine state of subdivision, and its uses in the horticultural and veterinary world are increasing rapidly. Toilet soaps containing this colloidal sulphur are also exhibited.

Quite as a side item to the company's business, the Premier Mill is being demonstrated, together with a number of products prepared by this machine, including paints, enamels, emulsions, finely ground pigments, etc.

(*To be continued.*)

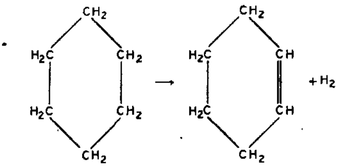
A STUDY OF THE DESTRUCTIVE DISTILLATION OF COAL.

BY E. V. EVANS, F.I.C.

The Second of Three Cantor Lectures delivered before the Royal Society of Arts, March 3.

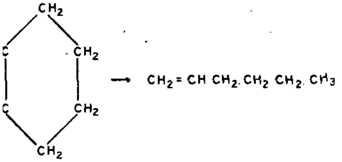
(*Continued from Page* 197.)

The decomposition appears to commence either with the elimination of hydrogen, forming the compound cyclohexene, or, by



CYCLOHEXENE.

direct fission of the ring, when molecular rearrangement will take place, resulting in the formation of an open-chain hydrocarbon of the unsaturated type, as, for example, the olefine n.hexylene.



A film, made by Mr. E. Aston Dyer, showing this decomposition of cyclohexane to cyclohexene and to n.hexylene, was shown.

The two reactions proceed simultaneously. The two products of decomposition may undergo further decomposition on heating. Using the conception of $CH_2=$ residues, originated by Prof. Bone, it may be imagined that this hypothetical group becomes separated from the rest of the molecule by a breaking of the double bond. The remaining portion undergoes rearrangement with formation of amylene.

$$CH_2 = CH.CH_2.CH_2\ CH_2.CH_3.$$
$$\rightarrow CH_2 = CH.CH_2.CH_2.CH_3 + CH_2=$$

Amylene.

This was illustrated by a film.

Amylene itself may similarly be decomposed, giving butylene; and this in turn may yield propylene and then ethylene. Ethylene may finally decompose into two $CH_2=$ groups.

$$CH_2 = CH.CH_2.CH_2.CH_3 \rightarrow$$
$$CH_2 = CH.CH_2.CH_3 + CH_2 =$$

Butylene

$$CH_2 = CH.CH_2.CH_3. \rightarrow$$
$$CH_2 = CH.CH_3 \quad + CH_2 =$$

Propylene.

$$CH_2 = CH.CH_3 \rightarrow$$
$$CH_2 = CH_2 \quad + CH_2 =$$

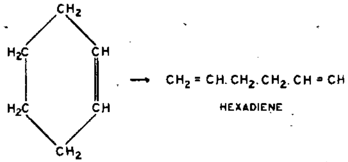
Ethylene

$$CH_2 = CH_2 \rightarrow$$
$$CH_2 = \quad + CH_2 =$$

These $CH_2=$ residues do not exist as such.

Cyclohexene also cannot resist further decomposition, owing to the presence of the double bond. The major portion is converted to open-chain unsaturated compounds. The initial product is probably hexadiene, and this may undergo further decomposition, splitting off $CH_2=$ residues, and giving rise to butadiene, and finally acetylene.

A film showing the decomposition of cyclohexene to hexadiene was shown.



$$CH_2 = CH.CH_2.CH_2\ CH = CH_2$$
$$CH_2= + CH_2 = CH.CH = CH_2 + CH_2=$$

Butadiene

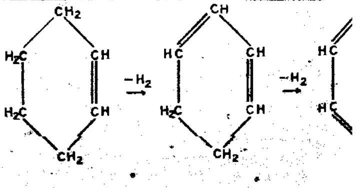
$$CH_2 = CH.CH = CH_2$$
$$CH_2= + CH \equiv CH + CH_2=$$

Acetylene.

Acetylene may then break down either to hypothetical $CH\equiv$ residues, or carbon and hydrogen.

$$CH\equiv CH \rightarrow CH\equiv + CH\equiv$$
$$CH\equiv CH \rightarrow 2C \quad + H_2$$

A small portion of the cyclohexene undergoes loss of hydrogen, resulting in the formation of benzene. Dihydrobenzene possibly represents a transition stage.

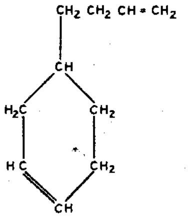


CYCLOHEXENE. DIHYDROBENZENE.

Some polymerisation and condensation of the unsaturated molecules may take place, resulting in the formation of high boiling-point unsaturated and aromatic compounds. Thus, butadiene and hexadiene may unite to produce tetrahydrophenylbutylene,

$CH_2 = CH.CH = CH_2 + CH_2 = CH.CH_2.CH_2.CH = CH_2$

BUTADIENE ↓ HEXADIENE



$C_6H_9.CH_2.CH_2.CH = CH_2$

TETRAHYDROPHENYLBUTYLENE

which on dehydrogenation may give phenylbutylene.

$$C_6H_9.CH_2.CH_2.CH = CH_2 \rightarrow C_6H_5.CH_2.CH_2.CH = CH_2 + 2H_2$$

phenylbutylene.

This compound is capable of condensing to naphthalene,

$$C_6H_5.CH_2.CH_2.CH = CH_2 \rightarrow C_{10}H_8 + 2H_2.$$

A film showing the formation of naphthalene from butadiene and hexadiene was thrown on the screen.

The olefines referred to may be hydrogenated to paraffins. A glance at fig. VI. indicates that there is always present for this purpose sufficient hydrogen produced during decomposition. In this way, hexylene may be converted to hexane. Similarly, pentane, butane, propane, and ethane may be formed from their corresponding unsaturated hydrocarbons.

$$CH_3.CH_2.CH_2.CH_2.CH = CH_2 + H_2$$

Hexylene

$$\rightarrow CH_3.CH_2.CH_2.CH_2.CH_2.CH_3$$

Hexane.

A reverse change may, however, occur, resulting in the formation of methane and an olefine containing one carbon atom less than the original paraffin. Thus, hexane may give rise to amylene and methane.

$$CH_3.CH_2.CH_2.CH_2.CH_2.CH_3$$
$$\rightarrow CH_2 = CH.CH_2.CH_2.CH_3 + CH_4$$

Amylene Methane

The relative proportions in which these products are present is influenced by the temperature at which the cracking takes place. Fig. VII. shows the relative proportions of the important products formed at three different temperatures, 650°, 700° and 750° C. The proportions of free carbon and gas increase with the temperature, while the liquid decomposition products become more aromatic in character. The insignificant amount of benzene produced calls for attention.

Hydrocarbons of the cyclohexane and cyclohexene type are the main gas-yielding constituents of primary tar. The gas resulting from their decomposition is rich in unsaturated compounds, together with ethane and methane, and is consequently of high calorific value.

The higher aromatic compounds, such as naphthalene, anthracene, &c., are formed to an appreciable extent by the polymerisation and condensation of the unsaturated compounds present in the gaseous decomposition products.

Direct dehydrogenation, with the formation of benzene and its homologues, takes place only to a very small extent, insufficient to account for the quantity of these compounds present in high-temperature tar.

Cyclohexane lends itself admirably to the cracking process, and it is probable that the gas industry depends greatly upon the cracking of hydrocarbons of this type for the production of gas sufficiently rich to allow the subsequent admixture of water gas without unduly lowering the calorific value below that requisite for economic distribution. Such hydrocarbons as cyclohexane are selectively cracked in the decomposition of primary tar, leaving a residue of secondary tar which is less suitable for further cracking. This question of the cracking of primary and secondary tars has been studied

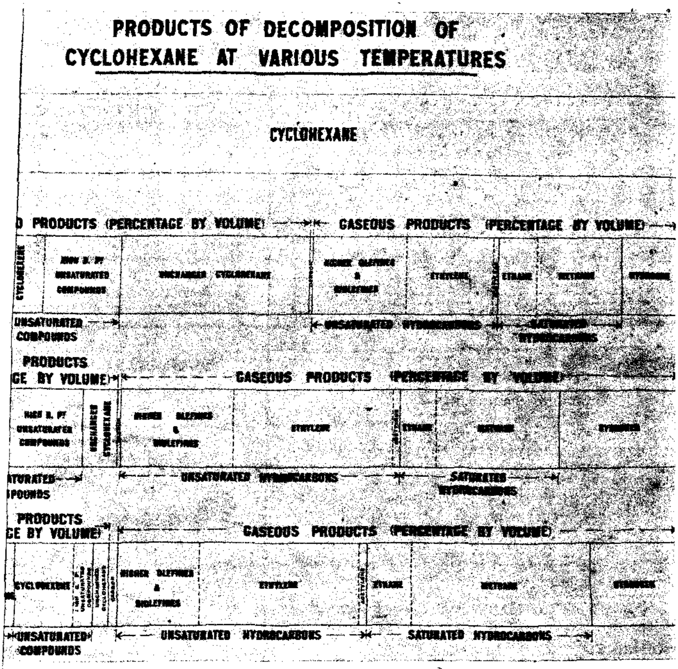


Fig. VII.

xperiments in which high and ure tars have been cracked. eriments, high and low temhave been heated to various the tar vapours being cracked ke in the presence of nitrogen The results of these experi sented, but the actual chemiwhich have taken place are

tube, 36 in. long (fig. VIII). separate furnaces at different ngth, were placed a boat conof tar to be heated by one fur quantity of coke, a short dis to be heated by the other furnace and to act as a heated contact material for the cracking of tar. A stream of nitrogen or coal gas was passed slowly through the tube from the tar boat end, the gases and condensable liquids being conducted away from the opposite end. The method of procedure was first to heat the coke to a definite temperature; and, this having been done, the contents of the boat were heated to a similar temperature over a period of either two or four hours. High and low temperature tars were used. It will be readily appreciated that the conditions of these experiments are very dissimilar to those which may take place during the cracking of tar in the carbonisation process on a large scale.

With a low-temperature or primary tar, a fair yield of gas was obtained at temperatures as low as 600° C. Much of the tar was of the nature of a secondary was recovered as a liquid, which

FURNACE USED IN THE CARBONIZATION OF BRIQUETTED COAL AT VARYING RATES

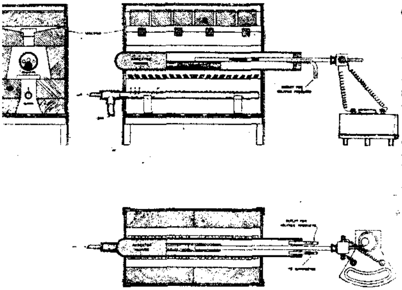


Fig. VIII.

tar. The residue was a pitchlike coke, while that remaining at higher temperatures was virtually a coke containing practically no volatile matter. The yield of gas and tar recovered at this temperature was about 62 to 74 per cent., whereas at 800° C. the yield was less satisfactory. At 980° C. the process had already become poor from the point of view of total yield—the efficiency of cracking to tar and gas having been reduced to 30 to 40 per cent. The tar recovered at this temperature was small and of inferior quality. With increasing temperatures the gas itself suffered considerable deterioration, the hydrocarbons having been largely decomposed, and the hydrogen percentage increased. The gas made at the lower temperatures was rich in saturated and unsaturated hydrocarbons, and poor in hydrogen. The vital necessity of clearing the rich gas from the retort as quickly as possible, and avoiding long contact with heated surfaces, was clearly demonstrated in the experiment at 700° C., where an extension of the duration of the experiment from two to four hours resulted in a considerable degradation of the gas, the unsaturated hydrocarbons alone having decreased from 9 to 2.6 per cent.

In the cracking of high-temperature tar, the yields by weight of gas and tar at 1000° C. only amounted to 20 per cent., while only 25 per cent. of the thermal value of the tar was recovered as gas—and very poor gas too. But, above all, it should be noted that the residual tar obtained by this procedure was little else than free carbon. In all cases of the cracking of this high-temperature tar the gas consists mainly of hydrogen. Only a small percentage of unsaturated hydrocarbons is present, and methane is also a much less important constituent.

The compounds present in high-temperature tar are comparatively stable, having resulted from the decomposition of less stable bodies, and are only decomposable at the highest temperature of carbonisation. They decompose mainly by the elimination of hydrogen, and the formation of compounds of increasing molecular complexity, and the process seems to end in the formation of carbon itself. The yield of gaseous therms obtainable from such a tar is limited, and can only be attained by sacrificing at considerable loss valuable constituents such as benzene and its homologues, thus rendering the tar of little value industrially.

The important conclusion to be drawn is that the cracking of high-temperature tar is uneconomical. The yields and quality of gas produced are poor, while the nature of the tar is so degraded that it is practically valueless.

(To be continued.)

CALCIUM ARSENATE—MONOPOLY ABSURDITY.

By H. W. Ambruster.

(Concluded from Page 160.)

If it is expected or even hoped that I may indicate any definite solution of this arsenic situation to-night, I am sorry to disappoint you. The real facts as to the demand must be indicated before anyone can do that safely. But to help in the solution, I am trying to set forth the controlling factors. When we get them properly outlined a solution can and will come, and I know of no other possible agency toward that end that can be as effective as the national campaign that is being initiated at this convention. The stimulation of all agencies and the concentration of the scientific and industrial resources of the country on the general problem of boll weevil control will have its effect on the arsenic phase of it in increasing measure as the movement gathers strength.

What the South seems to need at this time is an abundant supply of calcium arsenate, and that means an abundant supply of arsenic. But it has got to be cheap as well as abundant. If it was simply a question of arsenic or calcium arsenate at any price the problem would easily be solved. But as it stands, the cotton planter cannot even bid the arsenic away from the orchard owner or truck raiser.

Co-operative Buying.

One phase of the subject which is having a great deal of attention is that of co-operative buying of calcium arsenate. Personally I am neither for nor against the co-operative buying movement for calcium arsenate or any other insecticide through buying agencies under Federal, State or association control. There are many arguments—and votes—in favour of it, and also many arguments against it and reasons why it should be handled carefully to prevent more harm than good as a final result. But it is a perfectly natural development in an emergency such as now exists, and what I want to point out is this, that due consideration of economic laws and sound business practice be given in utilising it.

There is an old adage of law, I believe, which bids the buyers beware, and which means, I presume, that on the buyer is the responsibility of protecting his own interests in a purchase. It seems to me that an important point about co-operative buying as it is now practised is that is endeavours to put the shoe on the other foot, and that old adage should read in this connection, "Let the seller beware." And this condition not only does not help things, but it actually makes a bad situation worse.

I am going to close with an appeal for constructive co-operation between consumer and producer of boll-weevil poisons. I put the consumer first because his demand must come first, and he must appreciate just that fact if he wants producers to function efficiently or at all.

If this national boll-weevil campaign can assist toward that end, and I believe that it can, I am sure it will do one most constructive piece of work that needs doing very much indeed. After all, that kind of thing is just what this campaign is for, as I see it; to co-ordinate all agencies to the end that this pest be controlled and destroyed.

PROCEEDINGS AND NOTICES OF SOCIETIES.

THE ROYAL SOCIETY.

March 27.

Papers read:—

Prof. W. A. Bone, F.R.S., A. R. Pearson and R. Quarendon. *Researches on the Chemistry of Coal. Part III—The Extraction of Coals by Benzene under Pressure.*

A new form of apparatus was described for the extraction of coals by means of benzene under pressure up to 700 lbs. per square inch under "Soxhlet" conditions. It was shown that such an extraction method had considerable advantages over the usual pyridine-extraction methods for elucidation of the chemical constitution of coal. Also, the results of systematically applying the method to a wide range of bituminous to sub-bituminous coals (including the celebrated Morwell brown coal from Victoria, Australia), and of fractionating the crude benzene extracts by appropriate means, were discussed.

A large proportion of the benzene extracts from bituminous and sub-bituminous coals (except the said brown coal) always comprises an important group of nitrogenous "humic" bodies, which are mainly responsible for the coking propensities of bituminous caking coals, in which they are present to an extent of from 4.5 to 7.0 per cent. of the whole coal substance.

The amount of "resins" ordinarily contained in bituminous coals does not exceed, and in most cases is considerably less than, 1 per cent. of the whole coal substance; and whereas such substances undoubtedly possess binding powers, they ordinarily contribute in minor degree only to the coking propensities of the coals.

The non-coking characters of the semi-bituminous and sub-bituminous coals are primarily due to the comparatively small amounts of such humic and resinic compounds extractable from them.

The benzene extracts of all the bituminous coals examined contain important amounts of neutral wax-like non-nitrogenous bodies, of very low oxygen content, which do not, however, contribute at all to their coking propensities.

The residues left after completion of benzene extractions of bituminous coking coals are *per se* all practically devoid of coking propensities; but their physical characters

are probably not altogether without influence upon the actual coking process.

The extract from the Morwell brown coal, although in total amount exceeding that of any other coal examined, was of quite a different character, consisting chiefly of non-nitrogenous unsaponifiable resenes, resene-esters, and aliphatic or alicyclic acids (and esters), of which the two last are highly oxygenated substances.

R. V. SOUTHWELL *and* SYLVIA W. SKAN. *On the Stability under Shearing Forces of a Flat Elastic Strip.* Communicated by Prof. G. I. Taylor, F.R.S.

The investigation relates to a flat elastic strip, of uniform breadth, thickness and material, upon which a uniform shear is imposed by tangential tractions applied at its edges and in its plane. These tractions affect both the modes and the frequencies of the free transverse vibrations. If sufficiently intense, they will bring about a condition of limiting elastic stability, since they will neutralise, in certain types of distortion, the restoring effects of the flexural stresses.

J. E. P. WAGSTAFF. *Experiments on the Duration of Impacts, mainly of Bars with Rounded Ends, in Elucidation of the Elastic Theory.* Communicated by Sir Joseph Larmor, F.R.S.

A method depending on duration of discharge of a condenser through a circuit of known resistance and self-inductance has been developed for the accurate determination of duration of collision of steel bars.

E. V. EVANS and H. STANIER. *Sulphur Studies in Coal Gas. I.—The Removal of Carbon Bisulphide by a Nickel Catalyst.* Communicated by Prof. H. E. Armstrong, F.R.S.

In removing the sulphur present as carbon bisulphide from coal gas, the gas is passed over heated nickel. The products are mainly carbon and hydrogen sulphide. In most cases in which nickel is used as a catalyst in promoting combination with hydrogen, sulphur acts as a poison. An explanation of the apparently anomalous behaviour of carbon bisulphide has been sought. Proof is given that, in all probability, the actual catalyst is nickel subsulphide, Ni_3S_2.

Papers read in title only:—

N. AHMAD. *Absorption of Hard γ-Rays by Elements.* Communicated by Prof. Sir Ernest Rutherford, F.R.S.

By means of a balance method the absorption in a large number of substances of γ-rays from Ra B + C, filtered through 1 cm. of lead, has been measured. Complications due to hardening of the rays and secondary radiation have been avoided by using absorbers of equivalent thickness. The amount of secondary radiation entering the ionization chambers was limited to a definite fraction in all cases by a system of lead slits. With these and other precautions it was possible to obtain results strictly comparable among themselves and accurate to 1/400.

The results indicate that the laws of absorption of these penetrating radiations are of the same type as for X-rays. It was found that the apparent atomic absorption (μ_a) can be represented by

$$\mu_a = 1.68 \times 10^{-25} z + 1.60 \times 10^{-31} z^4,$$

where z is the atomic number of the absorber. The first term of this formula is considered to represent the part of absorption due to scattering, the second term that due to "true" absorption. For elements of low atomic weight, the apparent absorption is almost entirely due to scattering, and for those of high atomic weight at least one-half.

Estimates of wave-length, based on the two terms in the above formula, lead to values 0.015 and 0.019 A.U. for the *mean effective wave-length* of the radiation employed. These are in good agreement between themselves and with the indications of other work.

THE CHEMICAL SOCIETY.

APRIL 3.

Papers read:—

The Tautomerism of the Dyads. Part II.—Acetylene and its Halogen Derivatives, by E. H. INGOLD (Usherwood).

The Potassium Salts of Phenolphthalein, by H. BASSETT and D. J. T. BAGNALL.

A Phase-rule Study of the Cupro-, Argento-, Auro- and Thallo-Cyanides of Potassium, by H. BASSETT and A. S. CORBET.

The Hydrolysis of Potassium Ferricyanides and Potassium Cobalticyanide by Sulphuric Acid, by H. BASSETT and A. S. COR-

SOCIETY OF PUBLIC ANALYSTS AND OTHER ANALYTICAL CHEMISTS.

A meeting was held on April 2, when the following papers were read:—

A Report on the World's Dairy Congress, held at Washington, D.C., U.S.A., was made by JOHN GOLDING, D.S.O., F.I.C., who represented this Society.

The Routine Examination of Dairy Products, with special reference to the Mojonnier Tester, by L. H. LAMPITT, D.Sc., F.I.C., E. B. HUGHES, B.Sc., F.I.C., and M. BOGOD, B.Sc., A.I.C.

Experiments on the Absorption of Copper following the Consumption of Vegetables containing Copper Sulphate, by J. C. DRUMMOND, D.Sc., F.I.C., MISS M. G. PALMER, B.Sc., and MISS D. E. WRIGHT, B.Sc.

Determination of Sugar in Urine by means of Fehling's Solution with Methylene Blue as Internal Indicator, by J. H. LANE, B.Sc., F.I.C., and L. EYNON, B.Sc., F.I.C.

Attempt to extend Mitchell's Colorimetric Method to the Catechol Tannins, by MISS P. H. PRICE, B.Sc. (Work carried out under the Investigation Scheme).

THE GEOLOGICAL SOCIETY.

MARCH 12, 1924, PROF. W. W. WATTS, Sc.D., VICE-PRESIDENT, IN THE CHAIR.

Communications read:—

Descriptions of Gasteropoda, chiefly in the late Mrs. Robert Gray's Collection, from the Ordovician and Lower Silurian of Girvan, by JANE LONGSTAFF (*née* Donald), F.L.S., F.G.S.

The Old Red Sandstone of the Cardiff District, by ALBERT HEARD, M.Sc., F.G.S., and RICHARD DAVIES, M.Sc.

A meeting was held on March 26, when the following communications were read:—

The Fossil Elephants of the Upper Thames Basin, by K. S. SANDFORD, PH.D., B.A., F.G.S.

Some Upper Viséan Caninid Corals, by H. P. LEWIS, B.A., F.R.S.

THE MINERALOGICAL SOCIETY.

MARCH 18.

Dr. A. E. H. Tutton, F.R.S., Past-President, in the chair.

Papers read:—

DR. L. J. SPENCER. *Alopalladium from British Guiana.*

Three small grains with the appearance of native platinum, from the gold and diamond washings on the Potaro river, answered to micro-chemical tests for palladium; but the material was brittle and consisted of a granular crystalline aggregate showing cleavages.

W. CAMPBELL SMITH (with Analysis by DR. G. T. PRIOR). *On Compact Chlorite from Bernstein, Burgenland, Austria.*

Specimens of compact dark green stone provided by the Styrian Jade Company proved to be chlorite intermediate in composition between pennine and clinochlore of Tschermak's classification of the chlorites: "Precious Serpentine," from the same locality, was analysed and identified as chlorite by Wartha in 1884.

H. C. G. VINCENT. *Chemical Analyses of Microgranite from Dufton, Westmorland, and of Mica from Burma.*

Analysis of the microgranite with porphyritic mica from Dufton showed an excess of soda over potash; the mica from Burma had the composition of a phlogopite like that of Burgess, Ontario.

THE JUNIOR INSTITUTION OF ENGINEERS.

On Friday, March 21, Mr. P. PARRISH delivered a lecturette, *Sulphuric Acid Plants, New and Old: Constructional Details and Working.*

The lecturer said that a ton of coal would yield about 12 lbs. of sulphur, and as twenty million tons of coal a year were carbonised in gas works, some idea could be obtained of the amount of sulphur recovered. A method of extraction which had been used now for many years was that of purification of coal gas by iron oxide. The backward rotation process of purification was now adopted extensively, and gave a closed cycle of reactions. Fifteen cycles could occur before it was necessary to clean

the purifying and oxidising chambers.

Mr. Parrish indicated the chemical actions which take place in the production of sulphuric acid, but remarked that practically all the theories advanced as to the true action of sulphuric plants were open to question. He showed a number of slides of acid plants in course of erection or repair, and described the method of lining the chambers with lead sheets. Sulphuric acid, *under 85 per cent. concentration*, he said, did not attack lead, and the life of a plant was limited to thirteen or fourteen years chiefly through mechanical strains causing the lead to leak.

The lecturer emphasised the need for regularity in working, and mentioned some early types of plant which could not be used efficiently. He said that the tower system was introduced to this country in 1912, and was intended for a combustion space of 4 cubic feet per lb. of sulphur. The Benner-Millberg plant had two chambers, and worked at a lower temperature than others, but the plant of the future, Mr. Parrish suggested, would be one in which the burner gases reacted with the nitrosyl acid in liquid form, in which case there would be only 1 cubic foot of space required per lb. of sulphur burnt.

THE ROYAL SOCIETY OF ARTS.

On Monday, March 31, the second Cobb Lecture, entitled *Certain Fundamental Problems in Photography*, was read by T. SLATER PRICE, D.Sc., PH.D., F.I.C., Director of Research, British Photographic Research Association.

ARRANGEMENTS FOR APRIL:

Friday, April 4, 4.30 p.m. (Ordinary Meeting): GEORGE MACAULAY BOOTH, Director of the Bank of England and of the Booth Steamship Company, Ltd., *The Amazon Valley and its Development*.

Monday, April 7, 8 p.m. (Cantor Lecture): DR. T. SLATER PRICE, Director of Research, British Photographic Research Association, *Certain Fundamental Problems in Photography* (Lecture III.).

Wednesday, April 9, 8 p.m. (Ordinary Meeting): FRANK HOPE-JONES, M.I.E.E., Vice-Chairman, British Horological Institute, *The Free Pendulum*. Professor C. Vernon Boys, F.R.S., will preside.

Wednesday, April 30, 8 p.m. (Ordinary Meeting): BRIGADIER-GENERAL SIR HENRY MAYBURY, K.C.M.G., C.B., Director-General of Roads, Ministry of Transport, *The London Dock District and its Roads*.

NOTICES OF BOOKS.

Building for Peace. II.—International Letters, by WILLIAM A. NOYES. Pp. 78. Cambridge: Messrs. Heffer & Sons, Ltd., 4, Petty Cury. 1924. Price 1s. 6d. net.

It has often been said that science is international; it recognises no distinctions of race or creed. As a general rule, scientists, from their training and contact with the laws of Nature, are sufficiently broad in their mental outlook to give national and political differences and aspirations a subsidiary place.

A conflict such as the great European War, with all the bitterness and hatred it has aroused, has brought in its train a very exacting time for great minds. Patriotism has loomed large and has overshadowed at times, reason and true judgment.

The great tragedy is to see many good and able minds of two cultured peoples still in intense antagonism, whilst there is so much constructive work to be done.

It is for the scientists of all nations to give the lead and endeavour to obtain a recognition of just claims with the objective of ultimate harmony.

In this little volume, Professor Noyes has collected letters he has written to or refrom distinguished scientists (chiefly chemists) on this subject. He has also incorporated, wisely, an appeal issued in February, 1923, by the Society of Friends, quotations from Theodore Roosevelt and President Coolidge, and a reparations proposal of his own, which he submitted to M. Poincaré.

After several visits to Germany, France, and other countries involved in the war, the reviewer holds very definite opinions, which are gradually becoming more general, in scientific circles at least, concerning the trend of the events, since the cessation of hostilities and the direction in which justice lies. Scientists among our Allies are so full of their own difficulties and the troubles of their nations, that they are unmindful of the problems that beset us and the hardships still to be endured in Britain. And if they are aware of the conditions under which their German and Austrian confrères,

together with the rest of the professional classes of the central powers, labour, their main feeling is one of satisfaction.

The conditions under which students now work in German university laboratories are well portrayed in a letter to Professor Noyes from an American student at Munich. Being an American, he could not have felt the expense of chemicals and apparatus so much as the ordinary German students, whose plight in these times can be more easily imagined than described.

Professor Noyes has produced an earnest and valuable contribution towards the attainment of a just and lasting settlement. The sooner this is achieved the better it will be for Science and for scientists in every country. J.G.F.D.

Tested Methods of Mineral Analysis, by B. T. KITTO. Pp. 125. London: Messrs. H. F. & G. Witherby, 326, High Holborn, W.C. 1924. Price 7s. 6d. net.

Detailed methods for the assay of various ores are described in laboratory phraseology in Part II., which constitutes the major portion of this book. This is preceded by a short first part, which briefly gives the precautions to be observed in sampling, and is followed by Part III., entitled "On Solutions."

From the analyst's point of view the object and scope of the book are excellent, but the execution leaves much to be desired. Sometimes substances are given their names in the text, but more frequently the formulæ are used instead.

In the account of the estimation of copper, Procedure A, p. 45, sodium thiosulphate is referred to as "hypo" or its formula is used. In Part III. it is termed "hyposulphite."

The standard solution of iodine used in the volumetric estimation of tin is made by dissolving 10.67 gr. iodine and 20 gr. potassium iodide in one litre of water. This is not a decinormal solution, which contains 12.7 gr. iodine per litre.

There are three figures. In two of these a conical flask is represented as being heated by a bunsen flame on a tripod without gauze or sand-tray.

Abridged Scientific Publications from the Research Laboratory of the Eastman Kodak Company. Pp. 237. Vol. VI. (1922).

This volume, issued by the Eastman Kodak Co.'s Research Laboratory, is an abridged collection of their scientific memoirs published during 1922. These number over thirty, and cover a comparatively wide field. They deal not only with some of the numerous problems connected with the photographic emulsion, but also bring experimental evidence to bear upon the theories of light action and development.

There is also a valuable resumé of the recent advances in Photographic Theory (Communication 165).

Much valuable information has been collected together from the various sources in which the papers were originally published. This will be a great convenience for photographic chemists and others interested in this work.

Vegetable Proteins, by T. B. OSBORNE, PH.D., Sc.D. Second Edition. Pp. XIII. + 154. London: Longmans, Green & Co., 39, Paternoster Row, E.C.4. 1924. Price 9s. net.

This monograph is one of the series on bio-chemistry issued under the general editorship of Profs. Plimmer and Hopkins. The first edition appeared in 1909, and since that date considerable progress has been made in the study of the vegetable proteins. To keep pace with this, much new matter has been added to the volume, including a chapter on the relation of proteins to acids and bases, which has been written by Prof. L. J. Henderson.

The book opens with a historical review, followed by an account of the occurrence and characteristics of proteins in different parts of the plants. There is a classification of the vegetable proteins, after which come a number of chapters on their properties and reactions.

An excellent bibliography is a feature of the monograph.

Corrosion Tests and Materials of Construction for Chemical Engineering Apparatus, by W. S. Calcott, J. C. Whetzel and H. F. Whittaker. Pp. VI. + 182. New York: D. Van Nostrand Company, 8, Warren Street. 1923. Price $3 net.

This monograph is a reprint of two papers by the authors from the *Transactions* of the American Institute of Chemical Engineers. It includes much tabular data on the various aspects of the subject. There is also a brief outline of the use of materials against specific substances and for certain chemical processes. The various methods available for preventing corrosion are considered, as is the theory of corrosion.

Corrosion may be represented by an ionic equation:—

$$M + \overset{+}{H} = \overset{+}{M} + H,$$

in which the electrically neutral atom, M, interacts with the hydrogen ion, H˙, with the resultant production of a metal ion, M, which takes up the charge, depositing this as free hydrogen on the surface of the metal.

The monograph will be useful to chemical engineers and works chemists, but possesses the disadvantage that the bibliographies are hard to search through for any special work.

LITERARY INTELLIGENCE.

A Fourth Edition of Sir William Bayliss's *Principles of General Physiology* has been prepared by a Committee of his friends, biologists, physiologists, and chemists, under the general direction of Professor A. V. Hill, F.R.S., partly in order to ensure that what the Editors consider the greatest book of its kind shall continue to be available for the service of the scientific public, and partly as a small but sincere tribute of regard and sympathy for Sir William Bayliss at the time of his present sickness.

The committee consists of N. K. Adam, E. D. Adrian, G. V. Anrep, J. Bancroft, F. F. Blackman, R. K. Cannan, A. J. Clark, H. H. Dale, J. C. Drummond, C. Lovatt Evans, W. O. Fenn, H. S. Gasser, J. Gray, D. T. Harris, H. Hartridge, D. C. Henry, A. V. Hill, T. Lewis, E. K. Rideal, A. D. Ritchie, Ruth Skelton, E. H. Starling.

They have avoided any considerable interference with the text of the third edition, but have attempted merely to make corrections of fact, necessary as a result of recent work.

The bibliography is brought up to date by reference to recent important papers.

It has been their wish to be able to assure Sir William Bayliss that this new edition contains nothing of fact, or theory, which he need hesitate to publish at the present time.

A photograph of Sir William Bayliss working in his laboratory, which was taken about four years ago by Professor H. S. Raper, has been added as a frontispiece.

Messrs. Longmans, Green & Co. hope to have this new edition ready for publication in July next.

BOOKS RECEIVED.

Colloid Chemistry, by The. Svedberg. Pp. 265. 1924. The Chemical Catalog Co., Inc., 19, East 24th Street, New York, U.S.A. $.300.

Directory of Paper Makers. Pp. 276. 1924. Messrs. Marchant, Singer & Co., 47, St. Mary Axe, E.C.3. 5s. net.

PUBLICATIONS RECEIVED.

Welding Rods and Fluxes, issued by the Suffolk Iron Foundry, Ltd., Stowmarket.

Report on the Fermentation Industries for 1923, by H. Lloyd Hind, B.Sc., F.I.C.

Forty-Fourth Annual Report of the Director of the United States Geological Survey to the Secretary of the Interior. Pp. 88.

State of Connecticut.

Forty-Sixth Report of the Connecticut Agricultural Experiment Station, New Haven, Connecticut; for the year 1922. Pp. X. + 51.

Production and Briquetting of Carbonised Lignite, by E. J. Babcock and W. W. Odell. Pp. VI. + 82.

The U.S. Department of the Interior, Bureau of Mines, has issued the following bulletins:—

Recovery of Gasoline from Uncondensed Still Vapours, by D. B. Dow. Pp. V. + 52.

Uses of Water in the Oil-Shale Industry, with particular reference to Engineering Requirements, by J. J. JAKOSKY, with a Chapter on the *Sanitation of Oil-Shale Camps* by A. L. MURRAY. Pp. VI. + 57.

Analyses of Ohio Coals. Pp. 39.

Standards for Electric Service. Pp. 344.

Spectroradiometric Analysis of Radio Signals, by CHESTER SNOW. Pp. 231 to 261.

Stresses in a few Welded and Riveted Tanks tested under Hydrostatic Pressure, by A. H. STANG and T. W. GREENE. Pp. 645 to 666.

A Comparison of the Deoxidation Effects of Titanium and Silicon on the Properties of Rail Steel, by GEORGE K. BURGESS and G. WILLARD QUICK. Pp. 581 to 635.

New Patents.

This list is specially compiled for The Chemical News by Messrs. Rayner & Co., Registered Patent Agents, of 5, Chancery Lane, London, from whom all information relating to Patents, Trade Marks, and Designs can be obtained gratuitously.

Latest Patent Applications.

6734, 6735—Chemical & Metallurgical Corporation, Ltd.—Treatment of lead chloride, etc. March 15.

404—Metal Traders, Ltd.—Production of sulphuric acid. March 12.

251—Naugatuck Chemical Co.—Treating styrol, etc. March 11.

092—Woodcock, W. G.—Manufacture of anthraquinone derivatives. March 10.

Specifications Published this Week.

88651—Nitrogen Corporation.—Ammonia synthesis autoclave.

11943—Hirchberg, L. M.—Compositions containing formaldehyde.

12045—Howard, H., and Alvord, E. B.—Process of making metal sulphides.

06134—Pereira, H.—Process for manufacturing 3.10 perylene quinone.

Abstract Published this Week.

10120—Naphthol sulphonic acids.—Masters, C. L., of Southern Dyestuffs Co., Nitro, West Virginia, U.S.A.

2-Naphthol-6 : 8-and-3 : 6-disulphonic acids.—2-Naphthol-6 : 8-disulphonic acid is isolated, from solutions containing it, for example, from the crude sulphonation product of β-naphthol, as its sparingly soluble dipotassium salt by addition of potassium salt; in the case of the sulphonation mixture lime is also added to neutralise free acid, the calcium sulphate filtered off, and the filtrate concentrated and cooled. 2-Naphthol-3 : 6-disulphonic acid is isolated from solutions containing potassium salts thereof by boiling with lime, whereby a basic calcium-potassium salt is formed and separates. An example is given in which β-naphthol is sulphonated at 60° C. for 48-60 hours, and the 6 : 8-disulphonic acid separated as the dipotassium salt and the 3 : 6-disulphonic acid as the basic calcium-potassium salt; the latter is then converted to sodium salt by treating with sulphuric acid to precipitate the calcium as sulphate,

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THE CHEMICAL NEWS,

VOL. CXXVIII. No. 3339.

A STUDY OF THE DESTRUCTIVE DISTILLATION OF COAL.

By E. V. Evans, F.I.C.

The Third Cantor Lecture delivered before the Royal Society of Arts, March 10.

(*Continued from Page* 217.)

It has been demonstrated that rapid carbonisation is essential for obtaining high gaseous thermal yields, owing to the fact that with rapid carbonisation the average temperatures maintained are higher than in the case of slow carbonisation, and the tar is subjected to a higher degree of cracking, gas being produced at the expense of tar. This practice is the most economical one to adopt in the gas industry, provided the cracking process is not carried to such an extent that the resulting tar possesses an appreciably lower market value, or that retort-house troubles are created in the form of stopped pipes.

It is now necessary to deal with the physical changes which take place when coal undergoes carbonisation. In a well-filled horizontal retort, with some 3 or 4 in. space above the charge, it is probable that the periphery of the charge, which is in direct contact with the walls of the retort, very rapidly attains a high temperature. The rate of heat transmission to the centre would, if the material were not undergoing constant physical change, be very rapid in the first few hours, but would decrease as the temperature of the charge approximated that of the retort wall. But the physical condition of coal changes during carbonisation, and particularly during the first few hours. These changes largely determine the rate at which heat is transmitted to the centre. Certain resinous constituents of coal melt readily, and it is probable that these, on fusion, tend to cement the whole charge into one mass; but, though there may be a period in which the whole charge of the retort is sticky or slightly plastic, it is impossible to imagine that there is any degree of homogeneity in the plasticity of the mass. It is conceived that the outer crust of the charge is very rapidly carbonised and cemented into coke. This may take place even while, in the centre of the charge, there exist pieces of coal which still retain their identity. As the temperature of the mass increases there is produced a plastic layer which forms a liquid wall through which the products of distillation from itself and from the interior of the mass have to pass. This layer is probably derived from the fusible constituents, and on decomposition, froths and bubbles, producing expansion of the coal charge and giving the coke a cellular structure. Now it is the cellular nature of the carbonised mass which is the cause of the low heat conductivity of the material, and it is thus indirectly the plastic layer which impedes the rate at which heat is transmitted through the charge. It is imagined that the gases evolved during the whole of this process fight their way to the wall of the retort, either through the plastic layer or through the cellular coke already produced, and, if evolved at the side or bottom of the retort, travel between the charge and the retort wall until they reach the space above the charge. An untold hubbub must take place as the plastic layer finds its way towards the centre of the charge, and is there gradually heated to the decomposition point. Whereas the gauntlet to be run by the volatile matter during the early stages of carbonisation was drastic, now every bubble of gas produced must fight its way through tar and other semi-liquid products, until it finds an exit. Each step it takes brings it into a hotter zone, and the gas molecule which we imagine started from the centre of the charge with a wonderful degree of complexity is so squeezed and pushed and heated and washed that by the time it finds its way through the coke it has been reduced to an appreciably simpler form. In all these reactions a certain time contact is necessary, and the final form taken by this molecule will depend largely upon whether it may be pushed or pulled out of the retort before sufficient time has been given to break it down completely.

This picture of the physical changes which coal undergoes on heating indicates that it is the plastic layer which prevents heat being rapidly conducted through the coal. The problem of increasing the heat transmission of the coal substance itself will be solved by adopting suitable means for preventing the formation of the plastic layer. In the absence of the plastic layer it is possible to effect rapid penetration of

heat through the charge, and one would in consequence anticipate an increased yield not only of gaseous therms, but also of total volatile therms. Now the plastic layer may be avoided, or at least materially reduced, by intimately admixing with the coal to be carbonised an inert absorbent material, such as coke or coke breeze. This material will avoid the formation of a plastic layer by providing an infinite number of small pores and channels through which gases may escape, and by absorbing the tar-like matter formed. Moreover, the tendency of the material to expand during carbonisation will be reduced, as the large cells which originate from the plastic layer will no longer be formed. These large cells constitute a great impediment to heat transmission, and with the particles of coal and inert material lying in close proximity during the whole carbonising period, a small celled structure will be produced, with the result that the rate of heat transmission will be considerably augmented.

By admixing coke with coal and briquetting without a binder, the rate of gas evolution is materially increased. For the purpose of demonstration equal weights of the same coal, one of which was briquetted with 25 per cent. of coke, were heated in silica bulbs in a furnace, the temperature of which was about 900° to 1,000° C. The rate of gas evolution was greater in the case of the briquetted mixture, and the effect of the inert absorbent material in the coal mass is to increase the rate of heat transmission. Such an experiment demonstrates that there is a visible difference in the rate of carbonisation when a briquetted coal-coke mixture is heated on an exceedingly small scale. Some results obtained when working with quantities of the order of a retort charge were presented. In fig. I. are seen the volume and calorific value curves obtained from the carbonisation of a 75/25 briquetted coal-coke mixture compared with those obtained from the carbonisation of coal under similar conditions. It is the curve relating to the briquetted mixture corrected to 100 per cent. coal that is important, as it shows the rate of distilling the coal itself.

VOLUME & CALORIFIC VALUE CURVES
OBTAINED IN THE CARBONISATION OF
[ORDIN]ARY COAL & BRIQUETTED COAL COKE MIXTURE 75/25

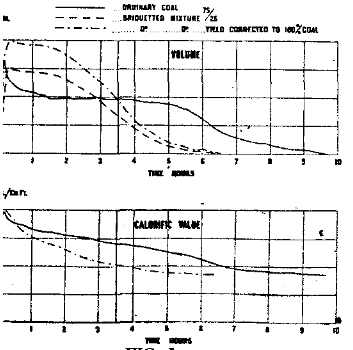
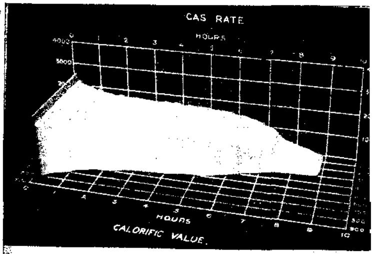
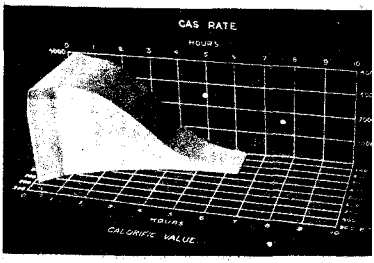


FIG. I.



COAL



BRIQUETTED COAL-COKE MIXTURE 75/25

FIG. II.

These curves indicate that the nature of the carbonisation process is entirely changed when a briquetted coal-coke mixture is used instead of ordinary coal. The carbonising process has been accelerated so that all the gas has been expelled from the briquettes in 6½ hours, as compared with 9½ hours in the case of untreated coal. As the difference between these two periods is 31½ per cent., it follows that the throughput of coal as 75/25 briquettes would be greater than were ordinary coal carbonised. Striking though the diagrammatic curve may be, it is here that the thermal models employed in the first lecture show so admirably the difference in the rate of carbonisation produced by the admixture of an inert material with the coal. Fig. II. shows the thermal models obtained from the carbonisation of ordinary coal and a briquetted coal-coke mixture.

It has been shown how striking is the difference between the amount of useful work effected in the retort during the middle ten minutes of the first hour, as compared with that effected during the middle ten minutes of the last hour of the carbonising period. This difference is greatly augmented in the briquetted coal-coke mixtures. Fig. III. shows three sections taken from the thermal model obtained from the 10-hour carbonisation of ordinary coal, and two sections taken from the thermal model relating to the carbonisation of an equal weight of a 75/25 coal-coke mixture. When briquetted material has lost practically all its volatile matter, a large amount of work is still being effected in the case of the slower carbonisation process of ordinary coal.

Thus the admixture of an inert material with coal increases the rate of gas evolution. The question arises whether this enhanced rate of gas evolution is accompanied by the superior thermal yield of gas which is to be expected from the results of the laboratory investigation previously described (Lecture II.).

Carbonising trials with briquetted coal-coke mixtures were carried out in an experimental, but up to the time of going to press it had been impossible to operate the setting in such a way as to obtain through the retort walls the required quantity of heat to effect the degree of tar cracking necessary to give the enhanced thermal yield of gas.

Very beneficial volatile therm yiel been obtained, however, in these ments, the results of which a ficient to demonstrate at least entirely new field is open for obt more economic distribution of the th the original coal. As many as 8 to tional volatile therms, which are times more valuable than non therms, have been obtained from th cular coal under test. These ad volatile therms are obtained at the of coke, and it will subsequently b sary to account theoretically for the redistribute the thermal energy of this newer way will constitute an in contribution to the coal conservati lem. The tar obtained in these

10-MINUTE SECTIONS TAKEN FROM

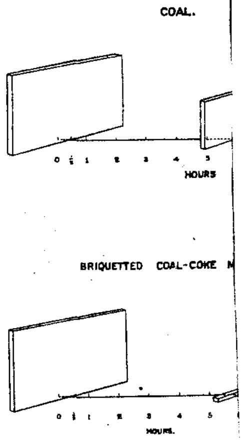


FIG. III.

ments was inclined to contain a high carbon content than that produced similar conditions from ordinary co coke produced, however, possessed v tinct advantages over the solid fuel p from the rapid carbonisation of c coal.

The question of carbonising briquetted mixtures has been studied from the point of view of obtaining the maximum yield of volatile therms, but other investigators have recommended the addition of inert matter to the coal in order to obtain a resulting solid fuel of high density and with a high degree of combustibility. That this solid fuel is indeed superior to coke has been admirably shown by E. C. Evans. It possesses a greater heat conductivity than ordinary coke, owing to the fact that the absence of the plastic layer has prevented expansion of the coal, with the result that a small-celled structure is produced. In consequence, combustion proceeds with greater velocity, while the powdered ash, instead of containing as much as 10 to 20 per cent. of combustible matter (as is often the case with coke) is practically free from carbon. Many

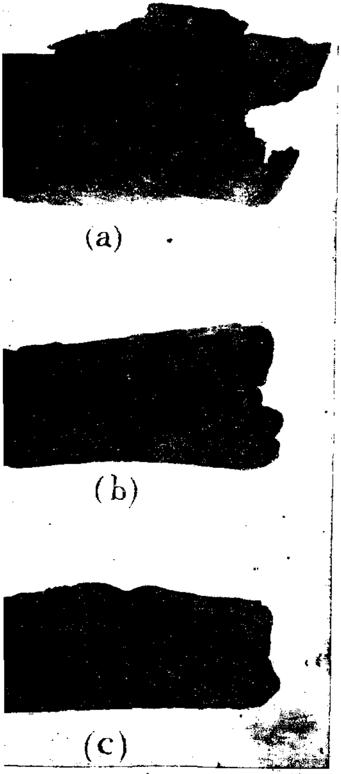


FIG. IV.

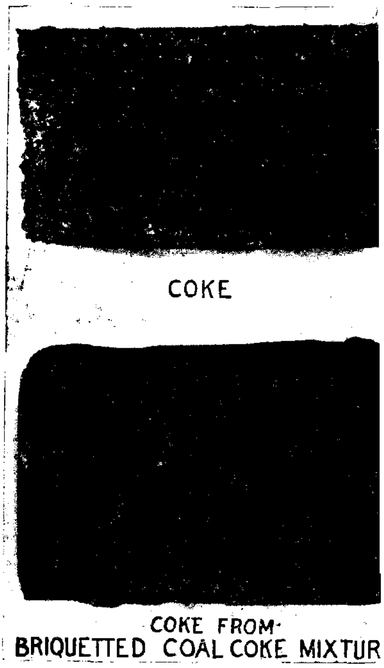


FIG. V.

investigators are engaged in a study of this fuel, and for several years now the author has worked upon this question, and recently in collaboration with E. R. Sutcliffe and E. C. Evans.

It was originally decided to admix inert material with coal in order to break up the plastic layer which prevented heat being readily transmitted through the mass. Firstly, it is essential to admix the correct proportion of coke, as is seen from fig. IV., which shows sections of briquetted fuel from (a) 100 per cent. coal, (b) 85/15 coal-coke mixture, (c) 75/25 coal-coke mixture. It will be observed that while the formation of the plastic layer is reduced in the case of 85/15 coal-coke mixture, it will only be avoided when as much as 25 per cent. of coke is admixed with the coal. That there is practically no plastic layer formed when the right proportion of coke is used in the briquette may be proved by the fact that if the distillation process is arrested at any time after the third hour the volatile matter remaining is evenly distributed throughout the briquette. The importance of this observation in supporting the contention that the plastic layer is avoided in briquette carbonisation is apparent.

Fig. V. shows sections of ordinary coke, and that obtained from the carbonisation of a 75/25 coal-coke mixture. These sections show the particular cellular structure so typical of ordinary coke, and the very dense small-celled coke produced when the formation of the plastic layer is avoided. The larger cells of the normal coke require a considerable amount of binding material, and a coking coal is one in which sufficient binding material remains after the period of expansion to allow the coke cells to be adequately cemented together during the shrinking process. With the production of a small-celled coke, such a large quantity of binding material is not required, and it is conceivable that a large proportion of the parent substance from which the binding material originates is distilled away and converted into volatile therms. This binding material is believed to be the source of the additional therms produced in the rapid carbonisation of coal and in briquette carbonisation. In order to develop this hypothesis an experiment was carried out, in which equal weights of coal (one being briquetted with 25 per cent. of coke) were heated in silica bulbs. The only difference between this experiment and the one previously described is that on this occasion the silica bulbs were heated directly by means of Meker burners in order to develop a very large heat potential in relation to the weight of coal taken. In the previous experiment special means were adopted to ensure that the total available heat was limited, and more in accord with large-scale practice. The rate of gas evolution is practically the same in both cases, owing to the fact that the quantity of heat available is so great that the coal charge is heated just as rapidly as the briquetted mixture. Under such conditions of drastic heating practically the whole of the binding material is converted into volatile matter.

It is often said that laboratory carbonisation of coal is of little value in forecasting the results eventually to be obtained on the large scale. That the laboratory distillation fails is due partly to the fact that the furnace is out of all proportion to the weight of coal charge used, and the amount of coke binding material evolved as volatile matter is higher than would be realised on the large scale. Further, the size of the retort in relation to the coal charge is also usually out of keeping with large-scale conditions, and a degree of tar cracking is practised which causes the results to be materially different from large-scale experience. The difficulty of designing laboratory apparatus to yield results comparable with large-scale practice is generally realised, but the author does not know whether the underlying cause of these differences is appreciated.

The question arises as to what is the maximum yield of volatile therms that may be obtained in the carbonisation of coal. This the author cannot answer, but one is faced with the fact that a small-scale laboratory experiment has yielded nearly 100 therms of volatile matter from a coal which under normal conditions of working has given only 90 and this yield should be aimed at on the large scale. It may be pointed out in passing that if this hypothesis be true, then the usual test for volatile matter in coal is of very limited utility for computing the value of a coal for gas-making purposes. The test is carried out by heating very rapidly an exceedingly small quantity of coal; and under these conditions of drastic heating the whole of the volatile matter is evolved, the coke is useless, and the result is one appreciably different from that eventually realised on the large scale. What is required to be known in computing the value of a coal is the proportion of volatile matter, which is recoverable as volatile therms under the conditions of the practical process to be adopted.

(To be continued.)

THE STRUCTURE OF OXYGEN.

By Hawksworth Collins.

In the demonstration of the structure of Neon and Argon in *The Chemical News*, this volume, February 8, it was shown—

(i) that the constitution of an atom of oxygen is

$$Li—H—H_3—H—H_3—H$$

(ii) that it is a non-metallic element owing to the presence of the two free portions, $H_3—H$;

(iii) that if the metallic portion Li—H had been greater in mass than the non-metallic portion, there would have been four electro-positive valences emanating from the four non-metallic portions, $H_3—H—H_3—H$, one from each. But, since the metallic portion is not greater in mass than the remaining portion, these four valences are quiescent, so that there are left only two electro-negative valences emanating from the two metallic portions, Li—H, one from each.

The word "free," as used above, is intended to imply that the two helium portions of oxygen are joined end to end, and are therefore free to vibrate, acting like the tail of a kite, thus causing the element to be gaseous at the ordinary temperature.

The above constitution for an atom of oxygen was obtained by reasoning upon only two sets of facts concerning the elements as a whole, *viz.*, atomic weight and valency. This deduction will now be proved to be true by means of two independent sets of facts, *viz.*, Specific Gravity (which gives Relative Volume), and Heat of Formation.

Table 1.

		O	=	Li — H — H_3 — H — H_3 — H
Acidic	....	7.53	=	1.54+0.97+1.54+0.97+1.54+0.97
Alcoholic	....	4.45	=	1.54+0.97+0 +0.97+0 +0.97
Neutral	....	2.51	=	1.54+0.97+0 +0 +0 +0

These volumes have appeared frequently in molecules already given, and will of necessity come into a great many later, so that no examples need be given here beyond the three substances in Tables IV., V. and VI.

It is evident from Table 1. that neutral oxygen is formed from acidic oxygen by the complete absorption of the two helium portions by the metallic part of the element; and that alcoholic oxygen is formed from *acidic oxygen by the withdrawal of only the* two H_3 portions within the metallic part.

That alcoholic oxygen easily becomes neutral oxygen by the withdrawal of the remaining non-metallic portions within the metallic part is shown by examples in Table 11.

Table II.

		Theor. S.G.	Obs. S.G.
Ethyl alc.	15.25+2(16.42)+4.45+5.76	0.789	0.789, 20° Mendelejeff.
Ethyl alc.	15.25+2(16.42)+2.51+5.76	0.816	0.815, 10° Regnault.
Prop. alc.	15.25+3(16.42)+4.45+5.76	0.803	0.804, 20° Bruhl.
Prop. alc.	15.25+3(16.42)+2.51+5.76	0.824	0.819, 20° Pagliani, i.e., 0.823, 15°.

Table III.

Heat of Formation of Oxygen.

H.F.			Original Volume		Relative Volume 15° C		Change of Volume
32341	=	795 × 2.54 × 16	10.07	=	7.53	+	2.54
71515	=	795 × 5.62 × 16	10.07	=	4.45	+	5.62
96155	=	795 × 7.56 × 16	10.07	=	2.51	+	7.56

The fact that they all give the same original relative volume (10.07) for oxygen when the Law of Heat of Formation is applied to them, proves that the volumes 7.53, 4.45 and 2.51 are absolutely correct. These three volumes were discovered in 1911, and were sent to the Nobel Institute in 1914, so that they have not been manipulated in order to fit in with the experimental data concerning the above-mentioned law, which was not discovered till 1920. The fact that they also fit in exactly with the Law of Relative Volume (see *The Chemical News*, February 15, 1924), which was not discovered till 1923, places the matter beyond all doubt whatever.

In addition to the employment of atomic weight, valency, relative volume and heat of formation to find and prove correct the results recorded in Table I., the experimental data concerning Optical Refractivity, Magnetic Rotation and Heat of Combustion will now be brought in to demonstrate further the fact that these three volumes of oxygen are really in existence.

The whole matter concerning the above has been called "The Correlation of Physico-Chemical Constants," and was sent to the Nobel Institute in 1922 and 1923, being diagramatically demonstrated by means of all available experimental data concerning 370 substances. The complete set of experimental data required is only obtainable in about twenty of these, from which the following three, which contain matter required for the present subject, are chosen.

TABLE IV.

Ethyl Alcohol.

	H +	$2(CH_2)$ +	O +	H	Theor. Values	Obs. Values
R.V. liq. ...	15.25 +	2(16.42) +	4.45 +	5.76	0.789, 15°	0.789, 20° Mendelejeff.
O.R. liq. ...	0.985 +	2(4.6135) +	1.747 +	0.82 =	17.3925,	17.42 Bruhl
M.R. liq. ...	0.235 +	2(1.023) +	0.108 +	0.399 =	2.788,	2.764 to 2.795 Perkin
H.C. gas ...	27100 +	2(157787) −	28500 +	26375 =	498336,	498360 Thomsen
H.F. gas	7280 +	2(7391) +	28500 +	8005 =	58567,	58470 to 57020 calc. by Thomsen
(H.F.) gas ..		2(96418) +	6(34380)	−340549 =	58567	

(R.V., O.R., M.R., H.C., H.F., (H.F.) stand respectively for Relative Volume, Optical Refractivity, Magnetic Rotation, Heat of Combustion, Heat of Formation, and the Exact Method of Calculating the Heat of Formation).

The heat of combustion of an atom of carbon, *i.e.*, the heat of formation of CO_2 is 96418. 96400 (obs.) Gottlieb mentioned by Thomsen. The heat of combustion of H_2, *i.e.*, the heat of formation of H_2O at 18° C., is 2(34380).

2(34180) Thomsen. 2(34500) Berthelot.

TABLE V.

Propyl Alcohol.

	H +	$3(CH_2)$ +	O +	H	Theor. Values	Obs. Values
R.V. ...	15.25 +	3(16.42) +	4.45 +	5.76	0.808,	0.8044, 20° Bruhl
O.R. ...	0.985 +	3(4.6135) +	1.747 +	0.81 =	17.3925,	17.42 Bruhl
M.R. ...	0.235 +	3(1.023) +	0.108 +	0.399 =	3.811,	3.759 to 3.779 Perkin
H.C. ...	27100 +	3(157787) −	28500 +	26375 =	489336,	489360 Thomsen
H.F. ...	7280 +	3(7391) +	28500 +	8005 =	65958,	65690 to 63660 calculated by Thomsen
(H.F.) ...		3(96418) +	8(34380) −	498336 =	65958	

TABLE VI.

Ethyl Carbonate.

	2H +	4(CH_2) +	C+	2(O) +	O		Theor. Values	Obs. Values	
R.V.	2(15.25)+	4(16.42)+	8+	2(7.53)+	2.51		0.969,	0.975, 19°	Erling
O.R.	2(0.985)+	4(4.6135)+	3.333+	2(1.654)+	1.346	=	28.411,	28.22	Bruhl
M.R.	2(0.235)+	4(1.023)+	0.633+	2(0.042)+	0.202	=	5.481,	5.481	Perkin
H.C.	2(27100)+	4(157787)+	128496−	2(25500)−	88530	=	674314,	674100	Thomsen
H.F.	2(7280)+	4(7391)−	32078+	2(25500)+	88530	=	151576,	152500 to 149310	calc. by Thomsen

(H.F.) 5(96418) + 10(34380) − 674314 = 151576

The matter cannot be demonstrated fully in a short paper, so that the condensed figures with regard to CH_2 will have to suffice for the present.

This proof of the constitution of oxygen is confirmed by deductions given in preceding papers, and will be further strengthened by succeeding papers.

THE ESTIMATION OF CADMIUM IN ALUMINIUM ALLOYS.

By N. F. BUDGEN, M.Sc.

Cadmium is sometimes added to pure aluminium, either to act as an alloying element, or, in very small quantities, for purposes of deoxidation. The observations recorded in this note were made during the course of research work on some such alloys, and were the outcome of an attempt to obtain a rapid and accurate method for their analysis.

Two methods are available for separation of the metals.

1. Precipitation of the cadmium as sulphide under definite conditions, followed by weighing as sulphide or conversion to sulphate.
2. Electrolytic precipitation of the cadmium.

Both have been repeated tried, and it is the object of this note to emphasise preference as regards both accuracy and rapidity for the second method. In the sulphide precipitation process, the conditions necessary for satisfactory results are as follows: A solution of about 2 gm. (of, say, a 5 per cent. cadmium alloy) in the minimum quantity of dilute (1:1) hydrochloric acid, is neutralised with ammonia, diluted to 200 cc. and then acidified with 7 cc. *concentrated hydrochloric acid to give the solution* a fixed acidity. The solution heated to 90° C. is saturated with hydrogen sulphide gas, whereupon a granular, orange-red precipitate of cadmium sulphide is thrown down. This method is open to the defects that, unless the conditions of working (acidity, etc.) are absolutely correct, there is difficulty in ensuring entire precipitation of the last traces of sulphide, furthermore the precipitate so obtained, if dried at 110° C., and weighed as such, gives results invariably 2 or 3 per cent. too high, due to the presence of a basic salt of composition CdS, $CdCl_2$. It is true that this latter disadvantage may be overcome by always working under identical conditions, or by converting the sulphide to sulphate, but by this last expedient an additional operation, providing opportunity for loss, is introduced. Also, this precipitate frequently contains free sulphur, so that in accurate determinations the dried precipitate must be repeatedly washed with carbon disulphide as long as any residue is left, when the last drops of the washings are evaporated upon a watch glass. Experiments utilising this method and made as checks with pure cadmium and aluminium accurately weighed to alloy compositions, but dissolved without melting together, gave results of which the following are typical:—

Alloy No.	Exactly weighed Composition. Al	Cd	Analytical Cadmium Per Cent. (weighed as sulphide).	Percentage error.
1	99	1	1.02	2.0
2	96	4	4.09	2.25
3	92	8	8.30	3.75
4	90	10	10.2	2.0

For the electrolytic method the following conditions gave every satisfaction:— About 2 gm. (of the 5 per cent. alloy) is dissolved in the least quantity of dilute (1:1) hydrochloric acid, and evaporated to strong fuming SO_3 with 10 cc. of concentrated sulphuric acid. The solution is diluted to 300 cc., raised to boiling, and electrolysed for 45 minutes, being re-heated after the first 20 minutes. A rotating anode, 300 (R.P.M.) and gauze cathode are used, with a curreut density of 0.25 amps. per square centimetre of surface and a pressure of 5 volts. The cathode deposit, which is matt and light grey coloured, is washed in water and absolute alcohol, dried in a steam oven at 100° C. for fifteen minutes and weighed.

Repeated experiments show that provided these conditions are adhered to, complete deposition is assured, and no trace of sulphide can be precipitated by H_2S gas from the solution after electrolysis. If the cadmium deposit is dark-coloured (blackish-grey) and poorly adherent, the result is invariably low, this condition apparently being induced by two great an acid concentration, which should not exceed 2 cc. concentrated H_2SO_4 per 100 cc. of solution.

Experiments utilising this method and made with pure cadmium and aluminium, as before, accurately weighed to alloy compositions, but dissolved without melting together, gave results of which the following are representative:—

Alloy No.	Exactly weighed Composition. Al	Cd	Analytical Cadmium Per Cent. (Electrolytic).	Percentage error.
1	99	1	1.001	0.1
2	96	4	4.010	0.25
3	92	8	8.102	1.27
4	90	10	9.954	0.46

From a comparison of these two tables it is seen that a far greater accuracy in the determination of cadmium is obtainable by the employment of the electrolytic method. From the point of view of time, also, there is an advantage for the latter over the sulphide method; the lengthy filtration process and conversion to sulphate or washing by means of carbon disulphide being dispensed with.

In conclusion the author wishes to acknowledge especial indebtedness to Professor T. Turner, M.Sc., A.R.S.M., F.I.C., for granting every facility for carrying out the investigation in his laboratories, and for his continued interest and advice.

The investigation was conducted in the Metallurgy Department of the University, Birmingham, with financial assistance from the Department of Scientific and Industrial Research.

CRITICAL STUDIES ON METHODS OF ANALYSIS.

X.—Cerium.

By Leon A. Congdon and Edward L. Ray.

[*Contribution from the Department of Chemistry, Syracuse University.*]

Introduction.

While cerium has not received very considerable attention from the quantitative viewpoint since its discovery by Berzelius in 1803, there is found in the chemical literature some seventeen original references pertaining to its exact estimation. Ten of these references pertain to cerium determined by volumetric methods—eight of which are by $KMnO_4$ and two by iodometric methods. The two gravimetric methods encountered are for the estimation of cerium as the oxalate nad weighing as such. One colorimetric method for the estimation of cerium in Welsbach mantles treats the cerium nitrates with H_2O_2 and NH_4OH in comparison tubes, and notes the intensity of the orange colour produced. The remaining references have to do with the separation of cerium from other rare earths by the effect of different oxidising agents progressively used, such as chlorine, bromine, iodine, H_2O_2, or $KMnO_4$, wherein cerium remains undissolved or precipitates in alkaline solutions.

The volumetric methods encountered, especially the permanganate methods, are quite varied as to their procedure. In one case *the cerium is precipitated once* as the oxalate and the oxalate estimated by standard $KMnO_4$ in accordance with the following equation:—

$$5C_2H_2O_4\ (2H_2O) + 2KMnO_4 + 3H_2SO_4 = K_2SO_4 + 2MnSO_4 + 10CO_2 + 8H_2O + (10H_2O).$$

Another author makes a double precipitation of the cerium oxalate and estimates as above. Several methods depend upon the use of reducing agents, such as standard ferrous ammonium sulphate or ferrous sulphate in excess and titration of the excess reducing agent with standard $KMnO_4$. Another method being the addition of standard $KMnO_4$, where the tetravalent cerium is acted upon and the extent of reduction of $KMnO_4$ being a measure. One method uses standard H_2O_2 in acid solution, the cerous previously peroxidised and the excess H_2O_2 measured by standard $KMnO_4$. Another method uses $K_3Fe(CN)_6$ and the $K_4Fe(CN)_6$ formed determined by standard $KMnO_4$. Then we have the direct titration of the cerous salt with standard $KMnO_4$, and if this salt is a nitrate, the hydrolysis is prevented by a neutralising agent, such as MgO.

Volumetric estimation of cerium by iodometric process depends upon the reaction of the oxide with KI and stronk HCl and estimation of the iodine set free.

This particular study takes up two gravimetric and two volumetric procedures, namely, Gibbs' (1) gravimetric oxalate method, where the cerium oxalate is dried at 100° and weighed as such; modified Gibbs' gravimetric oxalate-oxide metbod, where the cerium is weighed as the oxide; Bunsen's (2) volumetric iodometric method; and one phase of the $KMnO_4$ volumetric methods (3), where the cerous salt is titrated directly with standard $KMnO_4$.

EXPERIMENTAL.

The sample used in this investigation was C.P. cerous ammonium nitrate, $Ce(NO_3)_3 \cdot 2NH_4NO_3 \cdot 4H_2O$, containing only a faint trace of praeseodymium, otherwise free from other impurities. The theoretical percentage of cerium was 25.12.

All samples were weighed out by means of a glass stoppered weighing bottle.

The following table gives the results of the work:—

Method Used.	Wt. Sample in gram.	Theor. Amt. Ce %	Amt. Ce obt. %	Aver. Amt. Ce obt. %	Diff. from Theor. %
Gibbs' gravimetric oxalate	0.2942	25.12	25.40	25.48	+0.36
	0.2844		25.56		
Modified Gibbs' gravimetric oxalate-oxide	0.1023	25.12	25.70	25.61	+0.49
	0.1948		25.51		
Bunsen's Volumetric Iodometric	0.7791	25.12	25.65	25.52	+0.40
	0.9182		25.35		
	0.7668		25.57		
$KMnO_4$ Titration Volumetric	0.3191		25.85		
	0.3351	25.12	25.87	25.86	+0.74

DISCUSSION OF RESULTS.

The exact procedure used in Gibbs' gravimetric oxalate method in this study was to take about 0.2 gram of the salt and dissolve in water. A few drops of HCl were added, and then 150 cc. of water. This solution was heated to boiling, and the cerium precipitated as cerous oxalate, $Ce_2(C_2O_4)_3$, with a slight excess of hot dilute solution of $(NH_4)_2C_2O_4$, or oxalic acid may be used. The crystals of cerous oxalate were allowed to digest for one week (36 hours are sufficient). These were then filtered on a tarred Gooch crucible, wasbed, dried at 100° C. to constant weight, and weighed as the oxalate. The original procedure recommends the precipitate to be decanted on a weighed filter paper. However, because of the difficulty encountered in drying a filter paper

to constant weight this procedure is inadvisable, and the weighed Gooch crucible should be substituted. The method of piercing the filter and washing the precipitate into a crucible is also inadvisable, due to the persistency with which the fine particles of the precipitate cling to the filter. Some difficulty is experienced in getting constant weighings of the cerium oxalate, and weighings should be taken until they are constant. This gravimetric procedure gave the most accurate average results of any of the procedures tried.

The modified Gibbs' gravimetric method, where the cerium oxalate was prepared as above and then converted to the oxide, CeO_2, by ignition over a Tirril burner, will give average results nearly as accurate as the straight oxalate gravimetric method.

Bunsen's iodometric volumetric procedure was followed by taking about 0.2 gram of CeO_2, prepared by ignition of the $Ce_2(C_2O_4)_3$ *precipitate by Gibbs' process*, and placing in a distillation flask of a Bunsen apparatus composed of a distilling flask and retort. When the apparatus was connected, a few crystals of KI were introduced into the distillation flask, together with 25 cc. of conc. HCl. The flask was immediately stoppered and heated gently, until all the iodine liberated had distilled over into the retort which contained KI solution used for the absorption of the liberated iodine. The solution was now washed out of the retort and titrated with standard $Na_2S_2O_3$ solution. The iodine liberated serves as a measure of the cerium in accordance with the following reaction:—

$$2CeO_2+8HCl+2KI=CeCl_3+4H_2O+2KCl+I_2.$$

The iodine may be estimated when absorbed in KI by standard thiosulphate in acid solution, or in alkaline solution by standard arsenious acid. In this work N/20 solution of $Na_2S_2O_3$ was used. When ground glass joints cannot be obtained in accordance with Bunsen's apparatus, the authors have found that ordinary corks sealed with sealing wax furnish a means of substitution. Rubber stoppers cannot be used on account of the attack of iodine. Some difficulty may be experienced in completely driving the vapours of iodine into the KI solution in the retort. Other things being equal, this is probably the greatest source of error in this method. The results obtained by Bunsen's indirect iodometric volumetric method were nearly as accurate as Gibbs' gravimetric oxalate. Of course in this iodometric method results are dependent on separation of the cerium as an oxalate and conversion of this compound to an oxide, unless the sample analysed is already in the form of an oxide. The method is a more difficult one than Gibbs' method, and its accuracy is not quite so good in average results. Besides great adherence to detail is necessary in Bunsen's volumetric method.

The fourth method tried, that of the titration of the cerous salt with standard $KMnO_4$, needs some explanation. The procedure used was to dissolve about 0.3 grams of the original sample in 400 cc. of boiling water. Then standard $KMnO_4$ (N/10 solution used) is added to nearly complete the titration. At this point an excess of milk of magnesia (MgO) is added, and titration is finished at the boiling point with the standard $KMnO_4$. The equation involved is: $6Ce(NO_3)_3 + 2KMnO_4 + 4H_2O = 4Ce(NO_3)_4 + 2Ce(OH)_4+2KNO_3+2MnO_2$. In this reaction the $Ce(NO_3)_4$ is hydrolysed as follows: $Ce(NO_3)_4 + 4H_2O = Ce(OH)_4 + 4HNO_3$. Now, because of the HNO_3 formed, which tends to reverse the reaction, a suitable neutralising agent must be used, hence the MgO. There are some difficulties in this method which should be mentioned. The neutralising agent must not be added until the close of the titration, as low results will be obtained due to occlusion of some cerous hydroxide, and hence incompelte oxidation. Addition of the neutralising agent obscures the end-point somewhat, and the precipitate formed upon its addition must be allowed to settle partially so that the true end-point may be noted. The neutralising agent should be added in small portion, then the $KMnO_4$, and then the solution should be boiled to ensure permanence of the end-point. The results obtained by this method gave fairly good checks, but were much higher than the theoretical value.

The average accuracy of the above methods may be grouped in the following way, the most *accurate coming first*:—Gibbs' gravimetric oxalate; Bunsen's volumetric indirect iodometric; modified Gibbs' gravimetric oxalate-oxide; and the $KMnO_4$ titration volumetric.

SUMMARY AND CONCLUSIONS.

1.—Four methods for the estimation of cerium were studied and compared with the theoretical percentage of cerium in a

sample of cerous ammonium nitrate of known purity.

2.—According to this investigation, the average accuracy as to the theoretical percentage of cerium in the sample found the following methods to give higher results than the theoretical value, the most accurate coming first:—Gibbs' gravimetric oxalate; Bunsen's volumetric indirect iodometric; modified Gibbs' gravimetric oxalate-oxide; and the $KMnO_4$ titration volumetric.

3.—The best method found for the estimation of cerium is that of Gibbs, where the cerium is separated and weighed as the oxalate gravimetrically.

References:

(1) Gibbs, W., *The Chemical News*, 1865, X., 208; Dittrich, M., *Ber.*, 1908, XLI., 18; *The Chemical News*, XCIX., 96.

(2) Bunsen, R., *Ann. d. Chem. u. Pharm.*, CV., 49; Hanford & Hall, *The Chemical News*, 1900, LXXXI., 30.

(3) Brauner, *The Chemical News*, 1895, LXXI., 285; Browning & Lynch, *Amer. Jour. Sci.*, 1899, IV., 8, 457; *Zeit. Anorg. Chem.*, LIX., 71; Browning & Palmer, *Amer. Jour. Sci.*, XXVI., 83; *Zeit. anorg. Chem.*, LIX., 71; *The Chemical News*, 1908, XCVIII., 106; Gibbs, W., *Zeit. Anal. Chem.*, III., 395; *Ber.*, 1924 XXXIII.; *The Chemical News*, LXXXIII., 264; Lehner & Meloche, *Jour. Amer. Chem. Soc.*, 1916, XXXVIII., 66-70; Metzger, *Jour. Amer. Chem. Soc.*, 1909, XXXI., 523-5; Metzger and Heidelberger, *Jour. Amer. Chem. Soc.*, 1910, XXXII., 642; Stolba, Frantz, *Zeit. Anal. Chem.*, XIX., 194.

British Empire Exhibition,

PARTICULARS OF EXHIBITS.

(*Continued from Page* 213.)

W. J. Bush & Co., Ltd.

Visitors to the firm's exhibits at both stands will have an opportunity of obtaining an insight into the development of an interesting industry.

Following excellent work done during the war, since the armistice they have concentrated their attention on the production of fine chemicals which find application in essence making, confectionery, the mineral water trade, perfumery and soap-making. In accordance with their policy of business expansion, they also manufacture products which are of interest to lacquerers and varnish makers.

A glance at the list of chemicals which they manufacture justifies their claim to having done their utmost to establish a new British industry; the quality of their products can be relied upon, and the deep-rooted prejudice in favour of German chemical goods has almost disappeared.

At their perfumery stand, they show the products of Potter & Moore, and Buisson Frères, of which they are the sole proprietors.

Nearly two centuries ago, at Mitcham, *then a sleepy Surrey village, famous for the* fragrant lavender grown in its fertile soil, Potter & Moore founded a distillery for treating the delicate blossoms. Their lavender water, which conserves the perfume of the flowers to a remarkable degree, became an immediate favourite with the public of their day; from generation to generation this typical English perfume has delighted countless thousands. In the course of time, W. J. Bush & Co., Ltd., became the proprietors of Potter & Moore's business, and the same meticulous care is exercised in keeping the lavender water as fragrant, as sweet, as lasting, now as in 1749, when this perfume first made its appearance. Potter & Moore's 1749 Mitcham lavender water at the present day is firmly established as a favourite English perfume, and in deference to the wishes of their clientele, they have prepared numerous toilet articles in which this delightful odour is incorporated.

It is not within the scope of this article to describe in detail all the preparations which comprise the exhibit of Potter & Moore and Buisson Frères. Suffice it to say that the exhibit must be seen for its beauty and worth to be appreciated. A few outstanding popular perfumes perhaps deserve special notice, such as:—

Potter & Moore's world-famous 1749 Mitcham lavender water, 1749 Mitcham lavender soap, frozen lavender water, bath crystals, sachets, smelling salts, etc., 1749 Eau de Cologne, purple heather perfume, health bloom complexion cream and Devon violets; Buisson Freres' oriental poppy, Devonetta violets, golden gorse, frozen Eau de Cologne, *Devon lilies*, *Devonetta lilies*, l'Eveil d'Amour, bijou perfumes, toilet articles and hair preparations, and famous perfumes in cut-glass bottles; also handsome caskets of perfumery of every description. All the

firm's energies are directed towards making their British perfumery products worthy of the attention of buyers from all parts of the world.

THE CLAYTON ANILINE CO., LTD.

The firm is exhibiting in four show cases a complete set (about 250) of their colour types; also in two show cases all the intermediate products they are manufacturing (about 100).

In a special case they show certain typical colours with the corresponding intermediates, explaining the course of the manufacture from raw material to dyestuff.

In various other show cases they demonstrate the application of the various dyestuffs to the different kinds of materials and for the different trades, such as dyeing, printing, leather treatment, painting, etc.

D. & W. GIBBS, LTD.

The greater portion of the space occupied is given up to the complete manufacture of toilet soap, utilising normal size machinery and a full staff of workers.

This will be in no way a miniature model factory, but actual pieces of machinery picked up and laid down on the floor of the Exhibition.

In order that the public may see this properly a gangway has been made through the exhibit from one corridor to another. This will be slightly raised, and will allow the public to look down into the machines in action.

Naturally the whole process of soap-making it will not be possible to show, as this would entail boiling, and certain processes which are impossible for exhibition, but the processes of ribbon drying, compressing and perfuming, triple milling, cutting and stamping and wrapping of the final tablets will be shown, as practised in an up-to-date factory.

THE GAS LIGHT AND COKE COMPANY.

The Gas Light and Coke Company bears its 111 years of history lightly, and exhibits not only its well known range of tar, ammonia and cyanogen products, but emphasises its new developments, beta naphthol particularly, in a setting of derived intermediates.

Some of the samples point to higher standards of purity—Naphthalene of 79.3-79.5°, Cresol B.P. and pale Liquid Carbolic Acid of 99-100 per cent.

New shades of blue are also shown.

A working model demonstrates the ease with which the company's neutral sulphate of ammonia can be applied to the soil.

HICKSON & PARTNERS, LTD.

The exhibit will contain as its chief feature a large pigeon-holed show case showing the product samples of the intermediates and dyes. This case is so arranged as to illustrate the various stages in manufacture from the very simplest raw materials, crude benzol, sulphur and nitrate of soda, up to the finished dyes in the logical chemical sequence.

The firm's policy has been built up to follow logical chemical lines, as thus all stages are carried out at Castleford, saving all carriage and package from works to works at the various half-way stages.

Thus the firm work through nitro-compounds of benzene and its homologues, the important ones being nitro-benzene (mirbane oil), para-nitro-toluene and di-nitro-chlor-benzene. The next stage is simple monamines, of which the most important are aniline and para-toluidine. The firm are specialising on high purity out-of-the-way products, such as di-chlor-aniline, ortho-anisidine, etc.

At all of the foregoing stages purity has been their first aim, as they conceive this to be the vital factor in the establishment of a successful business in the manufacture of dyes.

They only make a few colours, but are tackling these on a large scale. Sulphur blacks, and of this group Vidal's latest type, Vidal Victory Black, are the next stage from the di-nitro-chlor-benzene mentioned above. The new Vidal victory blacks are gradually establishing their supremacy over the common type sulphur black, and are infinitely superior to the German pre-war types.

The product in which the firm claim to be pre-eminent in this country is roseine (magenta). Their policy of handing on all saving in cost to the consumer and aiming at large output at a small margin of profit has gradually built up a connection which is to-day literally overwhelming them with orders in this department, in spite of recent additions to the plant. To their satisfaction these orders are not merely for the home trade, but to-day they have some substantial contracts for delivery to the East, proving that they can compete well with Germany and America in the open world's market.

They have adopted the original British name of Brook, Simpson & Spiller, Roseine, for this product, believing in British names

for British products. The name Magenta is only one of considerably later use in this country.

As well as the stand mentioned above, they have cases showing patterns dyed on all classes of materials, with black, roseine, cerise, soluble blue, and other colours.

The curtains round the show case are dyed with Vidal victory black, roseine and soluble blue. These colours give a pleasing colour effect, and, in the form chosen, a striking contrast.

PROCEEDINGS AND NOTICES OF SOCIETIES.

THE ROYAL SOCIETY.

April 10.

Papers read:—

Prof. T. H. Havelock, F.R.S. *Optical Dispersion and Selective Reflection, with Application to Infra-red Natural Frequencies.*

J. H. Jones. *The Quantum Theory and the Dielectric Constant.* Communicated by Prof. O. W. Richardson, F.R.S.

A. M. Mosharrafa. *Half-Integral Quantum Numbers in the Theory of the Stark Effect, and a General Hypothesis of Fractional Quantum Numbers.* Communicated by Prof. O. W. Richardson, F.R.S.

E. A. Fisher. *The Discontinuity of the Drying Process.* Communicated by Prof. A. Smithells, F.R.S.

S. F. Grace. *A Spherical Source in a Rotating Liquid.* Communicated by Prof. G. I. Taylor, F.R.S.

THE ROYAL SOCIETY OF ARTS.

On April 7, the Cobb Lecture (III.), entitled *Certain Fundamental Problems in Photography*, was delivered by T. Slater Price, Esq., D.Sc., Ph.D., F.I.C., Director of Research, British Photographic Research Association.

At the Ordinary Meeting on April 9, a paper entitled *The Free Pendulum* was read by Frank Hope-Jones, M.I.E.E., Vice-Chairman of the British Horological Institute. Professor Charles Vernon Boys, F.R.S., presided.

THE ROYAL INSTITUTION OF GREAT BRITAIN.

The Friday evening discourse on April 11 was delivered by Prof. Jocelyn Thorpe, on *Colours, Stains and Dyes.*

THE OPTICAL SOCIETY.

April 10.

Communications presented and discussed:—

The Feasibility of Cinema Projection from a Continuously Moving Film, by H. Dennis Taylor.

A New Perfectly Anallatic Internal Focussing Telescope, by E. Wilfred Taylor.

INSTITUTION OF PETROLEUM TECHNOLOGISTS.

April 8.

The following paper was read:—

The Crude Oils of Burmah and Assam, by W. J. Wilson, F.I.C., A.C.G.I., M.Inst.P.T. The chair was taken by the President, H. Barringer, M.Inst.C.E., M.I.Mech.E., M.I.N.A., M.Inst.Mar.Eng.

THE INSTITUTION OF ELECTRICAL ENGINEERS.

The following is part of a new bye-law of the Institution of Electrical Engineers, which was adopted at a special general meeting of the Corporate Members held on February 28, and was allowed by the Lords of His Majesty's Most Honourable Privy Council on March 20:—

> "Every Member and Associate Member is, and is entitled to describe himself as, a Chartered Electrical Engineer, and in using that description after his name shall place it after the designation of the class in the Institution to which he belongs, stated in accordance with the following abbreviated forms, namely, M.I.E.E. or A.M.I.E.E., as the case may be."

THE CHEMICAL SOCIETY.

Ordinary Scientific Meeting, April 3.

Papers read:—

The Tautomerism of Dyads. Part II.—Acetylene and its Halogen Derivatives, by Edith H. Ingold (Usherwood).

The suggestion that acetylene, although consisting mainly of CH:CH, is in equili-

brium with a minute amount of *iso*acetylene, $C=CH_2$, has now been experimentally verified in two ways. The specific heat of acetylene was shown to vary with temperature in such a way as to indicate the existence of a mobile equilibrium similar to that shown to be present in hydrocyanic acid, where $H \cdot C:N$ is in equilibrium with a little $H \cdot N:C$. Also, chemical evidence of the existence of detectable quantities of *iso*acetylene at moderate temperatures has been obtained by a study of the mechanism of oxidation. The first product, previous even to formaldehyde (Bone and Andrew), is keten $CH_2=CO$, which is the normal oxygen addition product of *iso*acetylene $CH_2=C$, just as *iso*cyanates $R \cdot N=C=O$ are the normal first products from isonitriles, $R \cdot N=C$. It is possible that the low-temperature oxidation of acetylene takes place mainly through the *iso*acetylene form.

Chloracetylene and bromoacetylene also appear to be tautomeric substances of a similar character, and not, as Nef supposed, purely *iso*acetylene (acetylidene) derivatives. Thus chloroacetylene polymerises under the action of light to *s*-trichlorobenzene (evidence for $HC:CCl$), whilst with iodine it yields the compound $I_2C:C<^{Cl}_{H}$ (evidence for $C:C<^{Cl}_{H}$), and with hypobromous acid it gives both chloracetic acid and chlorodibromoacetaldehyde (evidence for both structures).

Further confirmation of the mobility of these substances is provided by the properties of the static dihalogen *iso*acetylenes. Like all bodies of this kind, the tendency to acquire the hydrogen atom necessary for tautomerism is so great that spontaneous reduction will occur. This is true of the static substance $CBr_2:C$ (Laurie), which is spontaneously reduced to the monobromo-compound in the presence of alkalies, and so readily does the same reaction take place with $CCl_2:C$ that all attempts to prepare this compound resulted in the isolation of the tautomeric monochloro-derivative.

The Potassium Salts of Phenolphthalein, by H. BASSETT and D. J. T. BAGNALL.

A phase rule study of the system phenolphthalein—potassium hydroxide—water at 25° has shown that the conditions which prevail are very similar to those found in the analogous system containing sodium hydroxide (Bassett and Halton, *J. Chem. Soc.* 1923, CXXIII., 1291). Although a number of hydrated forms of the mono-, di-, and tri-potassium salts of phenolphthalein can separate from aqueous solutions at 25°, they are all colourless. The behaviour of the tripotassium salt on heating to 150° suggests that a solid red salt is formed by elimination of one or two molecules of potassium hydroxide. No method of obtaining a pure red salt was found.

The Hydrolysis of Potassium Ferricyanide and Potassium Cobalticyanide by Sulphuric Acid, by H. BASSETT and A. S. CORBET.

Potassium ferricyanide was hydrolysed by sulphuric acid of varying concentrations, and the different products of hydrolysis were determined. With concentrated sulphuric acid, ferrous sulphate and carbon dioxide were obtained:

$$2K_3Fe(CN)_6+11H_2SO_4+13H_2O = 3K_2SO_4+6(NH_4)_2SO_4+2FeSO_4+11CO+CO_2.$$

With more dilute acid the reaction followed the course indicated by the equation:

$$2K_3Fe(CN)_6+6H_2SO_4 = 3K_2SO_4+Fe_2(SO_4)_3+12HCN.$$

The hydrolysis of potassium cobalticyanide by concentrated sulphuric acid was analogous to that of potassium ferricyanide, and could be represented by a precisely similar equation. With more dilute acid, hydrocyanic acid was obtained, as in the case of ferricyanide, but the hydrolysis was slow owing to the greater stability of the cobalticyanide. By long digestion under a reflux the amount of hydrocyanic acid obtained with dilute acid was that required by the equation:—

$$2K_3Co(CN)_6+6H_2SO_4+2H_2O = 3K_2SO_4+2CoSO_4+(NH_4)HSO+11HCN+CO_2.$$

A white compound of cobalt which appeared as an intermediate product of hydrolysis with dilute acid, was separated, whilst a white complex cobalticyanide was also obtained by the action of bromine on potassium cobalticyanide in aqueous solution. These substances appeared to be potassium aquopentacyanocobaltiates, analogous to the corresponding ferricyanide derivatives prepared by Briggs.

A Study of the Cupro-, Argento-, Auro- and Thallo-Cyanides of Potassium, according to the Phase Rule, by H. BASSETT and A. S. CORBET.

A phase rule investigation of the four systems KCN, H_2O and CuCN, AgCN

AuCN or TlCN, was given. In the case of the cuprous cyanide system the salts $K_3Cu(CN)_4$, $K_3Cu(CN)_4.H_2O$, $KCu(CN_2)$, and $KCu_2(CN)_3.H_2O$ were found to exist. Of these, all except $K_3Cu(CN)_4.H_2O$ were previously known. Three potassium argentocyanides were obtained, viz., the well-known compound $KAg(CN)_2$ and two new ones, $K_3Ag(CN)_4.H_2O$ and $KAg_2(CN)_3.H_2O$. The conditions under which the latter can be formed are very restricted. The bearing of the results obtained on Liebig's volumetric method for estimating cyanides was discussed. Only one aurocyanide, $KAu(CN)_2$, was obtained. In the case of thallium, a thallo cyanide, $KTl(CN)_2$, was found to exist, although it is stable in contact with solutions over only a very small range of concentrations. This compound is of interest because it contains univalent thallium in the anion.

THE OPPAU EXPLOSION.

The programme of the meeting of the Faraday Society, to be held on Monday, April 14, at 8 p.m., in the rooms of the Chemical Society, will include a report on an investigation of the chemical, physical and explosive properties of Oppau ammonium sulphate-nitrate, by Sir Robert Robertson and Dr. G. Rotter, with appendices by Dr. H. H. Thomas, Mr. A. L. Hallimond and Sir William Bragg. A short introduction by Sir Richard Threlfall will precede the report, giving briefly the conclusions of the Chemistry Research Board as to the causes of the Oppau explosion, which took place on September 21, 1921. Advance copies of the papers will be available (price 2s. to non-members), and application for them should be made to the Faraday Society, 10, Essex Street, Strand, W.C.2.

BOOKS RECEIVED.

Solubility, by JOEL H. HILDEBRAND, PH.D., Professor of Chemistry in the University of California. Pp. X. + 206. 1924. The Chemical Catalog Co., Inc., 19, East 24th Street, New York, U.S.A. [illegible]

A List of Official Chemical Appointments by THE REGISTRAR OF THE INSTITUTE. Pp XII. + 311. Fifth Edition, 1924. The Institute of Chemistry of Great Britain and Ireland, 30, Russell Square, W.C.

The University of Missouri, Bulletin No 26, Vol. 24, is a paper entitled *Experiments on the Extraction and Recovery of Radium from Typical American Carnotite Ores*, by HOWARD H. BARKER, with the collaboration of HERMANN SCHLUNDT.

The *Johannesburg Star* issued on March 11 its Special Annual Supplement, dealing with the year's progress in production and industry. A valuable resumé and review of trade conditions is given, and the outlook for the future is discussed.

New Patents.

THIS list is specially compiled for *The Chemical News* by Messrs. Rayner & Co., Registered Patent Agents, of 5, Chancery Lane, London, from whom all information relating to Patents, Trade Marks and Designs can be obtained gratuitously.

Latest Patent Applications.

7297—Pollak, F.—Manufacture of condensation products from urea, etc., and formaldehyde March 21.

Specifications Published this Week.

206158—Soc. Des Etablissement Barbet.—Apparatus for the production of formaldehyde by catalysis.

199032—Urfer, C.—Process for the synthetic production of ammonia.

191730—Roucka, E.—Indicating or recording physical or chemical quantities or qualities a a distance.

Abstract Published this Week.

210628—Sodium carbonates.—Sundstrom, C., and Tirziev, G. N., Syracuse, Onondage, New York, U.S.A.

A sodium carbonate having the composition $Na_2CO_3 3NaHCO_3$ is prepared by heating a mixture of sodium bicarbonate with sodium hydrate or carbonate such that the proportion of carbonic acid in the mixture is not less than the proportion in the desired compound. The temperature is preferably 95-100° C., and the process may be effected in an externally heated rotary furnace. The reaction is effected in the presence of a small proportion of water, which may be that contained in crude sodium bicarbonate or the water of crystallisation of sodium carbonate, but no considerable quantity of mother liquor is produced.

Messrs. Rayner & Co. will obtain printed copies of the published specifications and abstract only and forward on post free for the price of 1s. [illegible] each.

THE CHEMICAL NEWS,
VOL. CXXVIII. No. 3340.

A STUDY OF THE DESTRUCTIVE DISTILLATION OF COAL.

By E. V. EVANS, F.I.C.

he Third Cantor Lecture delivered before the Royal Society of Arts, March 10.

(*Continued from Page 229.*)

Now it has been shown that not aly is a maximum volatile thermal ield obtainable under conditions of rapid eating, but that moderately slow carbonisa-on is a tar-conserving process, and very ow carbonisation a coke-conserving one. In ıe slowest process tar distillation took lace, as well as gas evolution, and the itch left by the distillation of tar contri-uted to the yield of coke. The tendency to ugment the coke yield takes place in all ırbonisation processes, and the slower ıe process the greater the quantity of inding material left in the coke. Perhaps ıis analysis of the question presents a new ›nception of the carbonising process. The ıost satisfactory coke is produced by heat-ıg very heavy charges for long periods, 'hile the coke resulting from the rapid car-onisation of light charges yields a high per-›ntage of breeze. The problem therefore ›solves itself into either determining the ıinimum amount of binding material 'hich must be left in the coke to allow it to ›main a satisfactory material, or, prefer-bly, discovering some means of treating ıe coal substance prior to carbonisation so hat upon cokification it will yield a product 'hich is mechanically stable, but which re-uires a minimum amount of binding ıaterial. The latter problem has already een solved, for it has been demonstrated hat the carbonisation of briquetted coal-oke mixtures results not only in an in-reased yield of volatile therms, but also in solid fuel which is far superior to ordinary oke. The author does not wish to over-ıok the point that carbonisation may take lace under conditions which prevent a ırge degree of expansion of the coke, and it ı possible that the prevention of expansion y compression may result in an enhanced egree of tar cracking. Such a process does ot, however, result in the recovery of additional volatile therms, because the formation of the plastic layer is not avoided.

The whole organisation for dealing with the products of the distillation of coal (gas, tar, ammonia and coke) exists in the gas industry, and it is to this industry that the nation should look for the manufacture of a solid fuel which shall completely displace the use of raw coal both in industrial and domestic appliances. Our solid fuel business should extend in such a manner and with such an increased revenue per therm that it will reduce the selling price of the gas therm, and so cause gas to be even more generally applicable than it is to-day. There is a strong movement to achieve the smokeless city, and our responsibility in the future must also extend to the supply of solid household fuel for the open fire. If we fail to undertake this responsibility, others will step in and succeed. The author is not advocating low-temperature carbonisation, for he does not think that in the distillation of coal at low temperatures lies the solution of the household fuel problem. The low-temperature process labours under all the disabilities incurred by the production of a plastic layer during carbonisation. Not only is the distillation process a slow one, but, in consequence of the production of the plastic layer, the resulting fuel is large-celled and friable (unless special precautions be taken), while the binding material remaining in the coke is high. Distillation is carried on until the coal charge has been brought into equilibrium conditions at approximately 600° C., and as a result some 6 to 10 per cent. of volatile matter remains equally distributed throughout the mass. Were the process arrested before equilibrium was attained, an uncarbonised core would result, and the fuel would cease to be smokeless. It has already been indicated that in the case of coal-coke briquettes, the absence of the plastic layer allows heat to be transmitted so rapidly through the mass that after the first three hours the volatile matter is equally distributed throughout the coke.

Reference to the volume curve in fig. 1 shows a line at the 8½ hour stage. If the charge be withdrawn at this stage, 76 per cent. of the gaseous therms will have been evolved, leaving 5.6 per cent. of volatile matter (17 therms) well distributed throughout the solid fuel. It is thus possible to arrest the high-temperature distillation of briquettes after 8½ hours' heating and find 5.6 per cent. of volatile matter equally dis-

tributed throughout each individual briquette, and this applies practically to briquettes in the centre, as well as at the periphery, of the retort. This is an important observation, for low-temperature carbonising effects, as regards the resulting fuel, may thus be obtained under high-temperature conditions, and with a throughput of coal and yield of gas and tar which are very high. The resulting fuel will constitute an excellent substitute for raw coal in the household fire. It will, in fact, be greatly preferred, owing to its ease of combustion and its high radiation effect. It possesses, however, one great disability, which must receive careful attention, and that relates to its ash content. In order to obtain excellent results in the household fire, the ash content of this solid fuel should not surpass 5 to 6 per cent.

In addition to the two main claims of briquette carbonisation, there are other advantages arising from this method of distillation. In the first place, it is now a practicable proposition to arrest the distillation process when the amount of work being effected is of a very low order, so as to obtain the highest possible throughput of coal. Such a procedure would be impracticable if raw coal were undergoing carbonisation at a high temperature, for to arrest the process would result in an unburnt core in the charge, which would create retort-house annoyance, in addition to producing a friable coke from a portion of the charge. The introduction of briquette carbonisation in the gas industry would increase the range of coals suitable for gas-making purposes. It will have been seen from the picture already drawn that a coking coal is one which after the evolution of gas and the formation of large cells shrinks to such an extent that the whole mass holds together. The subsequent shrinking operation in the case of briquette carhonisation is certainly important in determining the final density of the fuel and its combustibility, but it is not nearly so important as heretofore, and in consequence a much larger range of possible gas-making coals is open to the gas industry.

The author then discussed various important engineering prohlems.

The main advantages of possessing coal in a state of fine division relate to the fact that not only may chemical treatment be applied to it prior to carbonisation, but the operation of de-ashing is facilitated. The

possibility of hydrogenating the coal substance prior to carbonisation, for the purpose of enhancing the yield of volatile products. That of de-ashing is one engaging considerable attention. It will naturally be a question of economics whether or not de-ashing should be practised at the colliery, but it is to be imagined that a large gas undertaking with a favourable solid fuel market and a cheap means of transport is likely to find the de-ashing of coal at the works to be the more remunerative process.

The first lecture presented certain facts which may be applied in practice to-day. The second also presented facts, but referred to those culled in the laboratory, while the third dealt with a few results, but also with a hypothesis which should be treated entirely as such.

All the work has received the inspiration and guidance of my chief, Dr. Carpenter, who more justly should have delivered these Cantor Lectures.

Finally it may be imagined that the large amount of work collected together could only have been carried out with the help of able assistants. It would be difficult to name all who have contributed in their work to the preparation of these lectures. May I therefore be allowed to tender my thanks to three senior assistants, Mr. H. Hollings, M.Sc., Mr. H. Stanier, B.A., and Miss E. Langdon, B.Sc.?

THE BRITISH DYESTUFFS INDUSTRY.

The following Memorandum has been approved by the Council of the Institute of Chemistry, and forwarded to the Board of Trade, to Members of Parliament, and to the Press:

Having regard to the wide discussion upon the position of the British Dyestuffs Industry and the possibility of an agreement being come to between the British Dyestuffs Corporation and the Interessen Gemeinschaft, the Council of the Institute of Chemistry, representing the main body of professional chemists in the country, desire to give publicity to their views on certain aspects of this matter, for the careful consideration of Members of Parliament and others concerned.

The Council hold the opinion that the progress which has been made in Great

tic dyes and their essential intermediates during the past ten years is very remarkable.

The industry as it exists to-day may be regarded as an entirely new creation rather than as an outgrowth from the small and languishing industry existing before the war. To take one striking example of this change, reference may be made to the highly specialised industry of vat dyes.

Prior to 1914 the modern vat dyes were entirely a monopoly of German and Swiss firms. Now these valuable and essential colours are manufactured by three or four British firms and, what is satisfactory to the users, the prices have been greatly lowered.

Nevertheless our present position is only comparable with that of the Germans before the war, in that we have been able to prepare in a pure conditions the dyestuffs hitherto produced by them. Except in perhaps one or two instances, the research work carried out does not represent new knowledge, and much remains to be done in the way of scientific research if we are to retain a position even of equality in the future.

Owiug, however, to the exceptional conditions prevailing in Germany in regard to rates of exchange and consequent amortisation of capital charges, the German makers have a very great advantage over our producers, and could at present undercut the latter completely, were it not for the operation of the Dyestuffs Act. Under this Act the Licensing Committee refuses applications for the importation from abroad of any dyes which are made in this country, provided the prices charged by British makers are not more than three times the pre-war prices of such so-called "contentious" dyes.

This arrangement — although a very severe test of industrial efficiency in the case of the more complex dyes still in an experimental stage — is nevertheless accepted under pressure in the majority of instances by the British dye makers, who are continuing to make good progress in improving their works processes and in extending their plants, so that their efficiency continually improves under the Act.

The preservation of our national independence in the matter of dyestuffs and fine chemical industries must remain for a period of years dependent upon some such protective policy, owing to the exceptional conditions briefly referred to above.

The Council of the Institute insist most strongly on the necessity, in the best interests of the nation, of developing and maintaining a successful dye-making industry. If it is maintained we shall have extensive and complicated plant and large numbers of highly trained and skilled chemists and chemical engineers available for the service of the nation in any time of emergency—an asset of immense value and importance.

The Council, while emphasising the great progress and success which has been attained already in this industry, desire to state that they are confident that the necessary skill and ability to achieve complete success are available, provided sufficient support is given meanwhile.

The Importance of Chemists.

A great and developing dyestuffs industry must maintain a very large staff of chemists in carrying out researches leading to the discovery of new dyes, in exercising the necessary scientific control to maintain efficiency, and in making improvements in existing processes. In addition to the large staffs directly employed, the operation of the dyestuffs factories stimulates other chemical activities which give employment to many professional chemists. Among the large-scale developments from the German dyestuffs industry may be cited the following:—The utilisation of atmospheric nitrogen (with its important bearing on agriculture and national defence), the manufacture of synthetic drugs such as aspirin, antipyrin and salvarsan, the production of photographic chemicals, synthetic tanning materials, artificial essences, flavourings, and resins, and more recently the discovery of preservatives against moths and insect pests.

The creation of such flourishing industries has a most stimulating effect on the scientific activities of the Universities. Prior to the war, the chemical schools of Germany became thronged with German and foreign students, and the atmosphere of research which was thereby engendered in all branches gave Germany the chemical hegemony of the civilised world.

As the result of the achievements made in developing the organic chemical and dyestuffs industry in Great Britain a similar repercussion has occurred between the industrial and academic branches of the chemical profession. For whereas in the

most important universities and colleges here were before the war about 1700 students being trained annually, there were, soon after the war, over 4,200 such students.

As a result of this increased activity, research schools have sprung into existence in our universities, comparable in size and in the standard of their investigations with the best schools of the Continent. Students, well instructed and trained in research methods, are at the disposal of industrialists for the chemical exploitation of our natural resources, without which we cannot hope to maintain our place among the nations.

PRODUCTIVITY.

Under modern conditions the power and pre-eminence of a modern state depend chiefly upon the application of scientific control to the forces of nature. In the preceding generation the application of physical science (engineering) has held greatest sway. In the present generation the greatest additional power is being derived from the application of chemical science, and the potentiality of a country in a large measure depends upon its ability to employ chemists productively for peaceful purposes. The influence of chemistry in procuring efficiency and cheapening production extends to every sphere of industry and of communal activity. It is felt that in discussions concerning the fostering of the chemical industry the vital interests of the country and of chemistry, on which so much depends, have received too little attention.

UNIFIED BRITISH EFFORT.

The Council of the Institute would view with disfavour any agreement entered into, even if favourable to the limited number of chemists employed by the British Dyestuffs Corporation, Ltd., which would act unfavourably towards the large body of chemists employed by the independent dye-makers and fine chemical manufacturers of this country. Any step taken by the Board of Trade should be, so far as possible, directed to the unification of British effort, which unification, apart from being desirable in itself, is necessitated by the powerful unification of the German Interessen Gemeinschaft.

TO SUM UP:

Great progress has been made in the dye-making industry, and the technical ability in this country to bring it to complete success and make this country independent of Germany, in this respect.

A successful dyestuffs industry provides a numerous personnel and large plant, able quickly, in time of need, to turn out a wide variety of complicated organic compounds —an important national asset. It provides in addition an excellent training school for industrial chemists.

It should be emphasised that the good position already won by the British dye manufacturers should be thoroughly safeguarded, so that the productivity of the British Dyestuffs industry should not in any way be curtailed or hindered.

On behalf of the Council of the Institute of Chemistry:

G. G. HENDERSON,
President.

30, *Russell Square, London*, W.C.1.
March, 1924.

CRITICAL STUDIES ON METHODS OF ANALYSIS.

IX.—CALCIUM.

By LEON A. CONGDON, W. PAUL EDDY, JR., AND ELVA SMITH MILLIGAN.

[*Contribution from the Department of Chemistry, Syracuse University.*]

INTRODUCTION.

The literature shows some forty-three important original references pertaining to the estimation of calcium. These may be divided as follows: Twenty-one are gravimetric, eleven volumetric, two indirect gasometric, two nephelometric and one each of colorimetric, centrifugal, photometric, and refractometric methods. Among the gravimetric may be mentioned the following: as oxalate, oxide, phosphate, sulphate, columbate, fluoride, and tungstate. The volumetric methods cover neutralisation, with use of different indicators, indirect iodometric, indirect permanganate, and precipitation methods. The indirect gasometric determinations make use of the formation of calcium iodate and decomposition of this product by action of hydrazine, the nitrogen gas evolved measured by a nitrometer. The photometric method uses special apparatus until image of the candle flame disappears. The immersion refracto-

oxalate, evaporated to dryness, taken up in 2 per cent. acetic acid, diluted to 10 cc., and then examined in refractometer and reference made to a table. The colorimetric method depends on the pale yellow colour of a colloidal solution of calcium oleate. Brunck (11) in 1906, Winkler (12) in 1918, and Ewe (13) in 1920, have made partial studies on the comparison of methods for the estimation of calcium. A summary or abstract of their work will be given later in the discussion of this article.

This particular study takes up the accuracy of the following ten methods: (1) A. Cossa's oxalate-oxide gravimetric; (2) S. Gay's and Souchay and Leussen's oxalate gravimetric; (3) A. Cossa's oxalate-oxide-sulphate gravimetric; (4) Fresenius' sulphate evaporation gravimetric; (5) Fresenius' sulphate precipitation gravimetric; (6) Fresenius' carbonate gravimetric; (7) A. Saint Sernin's tungstate gravimetric; (8) Fresenius' fluoride gravimetric; (9) Peters' indirect permanganate volumetric; and (10) Fresenius' neutralisation volumetric method.

Principle of the Methods Used.

(1) Cossa's oxalate-oxide gravimetric method depends upon the fact that calcium forms an insoluble precipitate (Sol. Product 2.5×10^{-7} at 25° C) of calcium oxalate by oxalic acid and ammonia, or a solution of $(NH_4)_2 C_2O_4$, with the addition of heat. After filtering the calcium oxalate, it is ignited to the oxide, in which form it is weighed.

(2) S. Gay's or Souchay and Luessen's oxalate gravimetric method weighs the calcium as precipitated in A. Cossa's method as $Ca C_2 O_4.H_2O$, after drying in an oven at 100° C. in a weighed Gooch crucible.

(3) A. Cossa's oxalate-oxide-sulphate gravimetric procedure is similar to method (1), except the CaO precipitate is moistened with water, a few drops of HCl added, then a slight excess of H_2SO_4. This is heated cautiously over a low flame to SO_3 fumes, then over a slightly higher flame until the excess acid is expelled. The $CaSO_4$ thus formed is ignited moderately and weighed as such.

(4) Fresenius' sulphate evaporation gravimetric method, for a solution containing salts of calcium only, if this is to be determined, adds a slight excess of H_2SO_4. This is evaporated on a water bath, then under a low flame to SO_3 fumes, and finally ignited moderately until excess of acid is expelled and finally weighed as $CaSO_4$ until constant weight is obtained.

(5) Fresenius' sulphate precipitation gravimetric process is based on the low solubility product of $CaSO_4$, when a solution of a calcium salt is precipitated with dilute H_2SO_4 in excess and twice the total volume of alcohol is added. This is allowed to stand 12 hours or more. It is then filtered, and the precipitate washed with alcohol. The precipitate is then dried and moderately ignited in a Bunsen flame to constant weight as $CaSO_4$.

(6) Fresenius' carbonate gravimetric method is founded on the low solubility product of $CaCO_3$, when a solution of a calcium salt is precipitated by adding an excess of ammonia and ammonium carbonate solution. This is allowed to stand several hours in a warm place, and is then filtered and washed with as small a volume of 1 to 10 ammonia solution as possible. The precipitate is dried and ignited at low red heat, and weighed as $CaCO_3$.

(7) A. Saint Sernin's tungstate gravimetric method depends upon the precipitation of $CaWO_4$ by adding an excess of ammonia and then an excess of a 20 per cent. solution of normal sodium tungstate to a solution of a calcium salt. The precipitate is filtered in a tarred Gooch crucible, washed with 1 to 10 ammonia, then dried at 100°, and weighed as $CaWO_4$.

(8) Fresenius' fluoride gravimetric process is based on the insolubility of CaF_2, when a calcium salt solution is treated with HF. The precipitate is ignited and weighed as CaF_2.

(9) Peters' indirect volumetric $KMnO_4$ method for calcium precipitates the calcium from a solution of its salt as the oxalate. The calcium oxalate is filtered and washed with 1 to 10 ammonia into a Gooch crucible. This is then transferred to a beaker and dissolved in a little warm dilute H_2SO_4, and diluted to 100 cc. with water, finally heating to 60° to 70°. This solution is then titrated hot with a standard $KMnO_4$ solution to a faint permanent pink colour. The reaction involved is:—

$$5CaC_2O_4 + 2KMnO_4 + 8H_2SO_4 = 5CaSO_4 + K_2SO_4 + 2MnSO_4 + 10CO_2 + 8H_2O.$$

(10) Fresenius' neutralisation volumetric method is based on the principle of dissolving the oxide, hydroxide or carbonate in standard HCl and titration of the excess acid with standard NaOH, using methyl orange as indicator. To obtain the calcium as carbonate or oxide the solution of the

calcium salt is precipitated as the oxalate and ignited. The ignited precipitate is transferred to a beaker, covered with water, and 0.5 normal HCl run in from a burette until solution is complete. Two drops of methyl orange are added, and nearly neutralised with 0.5 normal NaOH. The solution is then boiled a few minutes to expel the CO_2, a neutralisation completed with the standard NaOH.

Experimental.

The sample used in this study was C.P. $Ca(C_2H_3O_2)_2H_2O$, showing H_2S metals = none, heavy metals = trace, sulphate = trace, chlorine = 0.0011 per cent.

This salt of calcium was dissolved in water, a little HCl added, and diluted to 1,000 cc. at 20° in a volumetric flask. Aliquots of this solution were used for the various determinations. The theoretical per cent. of calcium in the sample was 22.74 per cent. All mtehods were carried out at least in duplicate, and in some cases many more times than that.

The following table shows the results of this study:—

Method Used.	Amt. Sample Gm.	Theor. % Ca.	Amt. Ca. obtained.	Aver. Amt. Ca. obt. %	Diff. from Theor. %
Cossa's oxalate-oxide	0.2423	22.74	22.90		
gravimetric			22.78		
	0.6323		22.46		
			22.23	22.55	-0.19
			22.15		
			22.80		
Gay's or Souchay &	0.2423	22.74	23.19		
Leussen's oxalate			23.03	23.31	+0.57
gravimetric	0.6323		23.46		
			23.54		
Cossa's oxalate-	0.2423	22.74	23.28		
oxide-sulphate			23.36	22.18	-0.56
gravimetric	0.6323		21.63		
			21.43		
Fresenius' sulphate	0.1975	22.74	23.25		
evaporation			23.55	23.40	+0.66
gravimetric	0.2423		23.36		
			23.44		
Fresenius' sulphate pre-	0.2423	22.74	22.86		
cipitation gravimetric			22.86	22.86	+0.12
Fresenius' carbonate	0.2423	22.74	22.90		
gravimetric			22.74	22.82	+0.08
Saint Sernin's	0.2423	22.74	23.57		
tungstate			23.44		
gravimetric	0.6323		21.68	22.67	-0.06
			21.98		
Fresenius' fluoride	0.2157	22.74	21.42	21.35	-1.39
gravimetric			21.28		
Peters' oxalate	0.2423	22.74	22.74		
$KMnO_4$			22.86		
volumetric	0.2948		23.40	23.03	+0.28
			23.11		
Fresenius'	0.2423	22.74	22.90		
neutralisation	0.4088		22.95		
volumetric	0.8060		23.59	23.39	+0.65
	0.2948		23.70		
			23.47		
			23.74		

Discussion of Results.

The average accuracy of the general methods for the estimation of calcium may be grouped in different classes.

1st: Those methods with an average accuracy within 0.2 per cent. of the theoretical per cent. of calcium are the following: Saint Sernin's *tungstate gravimetric;* Fresenius' sulphate precipitation gravimetric; and Cossa's oxalate-oxide gravimetric. 2nd: Those methods with an average accuracy within 0.7 per cent. of the theoretical per cent. of calcium are the following: Peters' oxalate $KMnO_4$ volumetric; Cossa's oxalate-oxide-sulphate gravimetric; Gay's or Souchay and Leussen's oxalate gravimetric; Fresenius' neutralisation volumetric; and Fresenius' sulphate evaporation gravimetric. 3rd: Those methods with an average accuracy within 1.50 per cent. of the theoretical per cent. of calcium are the following: Fresenius' fluoride gravimetric method.

Brunck (11) criticised the various gravimetric methods for the estimation of calcium and recommends the conversion of the ignited oxalate into fluoride by treatment with HF solution.

Winkler (12) in his study of the methods of estimating calcium, finds that precipitation as oxalate from a solution acidified with acetic acid in the presence of excess of NH_4Cl gives accurate results. He finds that the precipitate is best weighed as oxalate. He also obtained good results by precipitating the calcium from an ammoniacal solution and weighing it as oxide.

Ewe (13) compares ten different methods for the estimation of calcium. In his work calcium was determined by the following methods in a sample of calcite containing 0.0407 per cent. of impurities, (SiO_2, Al_2O_3, Fe_2O_3), the results being expressed as per cent. $CaCO_3$: (a) Precipitating as CaC_2O_4 and weighing as $CaCO_3$, 99.57; (b) precipitating as $CaCO_3$ and weighing as such, 100.07; (c) liberating CO_2 with HCl, absorbing in KOH solution and weighing, 100.08; (d) precipitating as CaC_2O_4 and weighing as CaO, 99.86; (e) precipitating as $CaSO_4$ and weighing as such, 99.68; (f) precipitating as CaC_2O_4 and weighing as $CaSO_4$, 100.39; (g) precipitating as CaC_2O_4 and titrating with $KMnO_4$, 99.68; (h) precipitating as CaC_2O_4 from a slightly acid solution, 99.87; (i) *liberation of* CO_2 by HCl and determining loss in weight in a Geissler apparatus, 99.80; and (j) decomposition by [illegible] 99.75

Summary and Conclusions.

1.—Ten different methods for the estimation of calcium in a sample of calcium acetate of known purity were investigated. The methods were Saint Sernin's tungstate gravimetric, Fresenius' carbonate gravimetric, Fresenius' sulphate precipitation *gravimetric,* Cossa's oxalate-oxide gravimetric, Peters' oxalate $KMnO_4$ volumetric, Cossa's oxalate-oxide-sulphate gravimetric, Gay's or Souchay and Leussen's oxalate gravimetric, Fresenius' fluoride gravimetric, Fresenius' neutralisation volumetric, and Fresenius' sulphate evaporation gravimetric.

2.—According to this investigation, the average accuracy as to the theoretical percentage of calcium in the sample claims the following methods to be entirely reliable: Calcium precipitated and weighed as the tungstate; calcium precipitated and weighed as the carbonate; calcium precipitated as the sulphate and weighed as such; and calcium precipitated as the oxalate and weighed as the oxide.

3.—According to this investigation and to three others (*loc. cit.*) calcium is best separated from a solution of its salts as an oxalate. It may, with care, be weighed as the oxalate, or best converted to the oxide and weighed as such.

4.—Calcium salts, when separated as the oxalate and changed to sulphate and weighed as such, give higher results than theoretical. This is also true of other calcium salts when converted to the sulphate by *evaporation with* H_2SO_4, *and the* calcium is weighed as the sulphate.

5.—All the other methods of analysis investigated other than those given in paragraph two of this summary, give results on the average higher than the average experimental error of 0.2 per cent.

References:

(1) Cossa, A., see Fresenius' "System in Chemical Analysis," Vol. II., 234; McCrudden, *Jour. Biol. Chem.*, 1910, VII., 83; *Ibid.*, 1911, X., 187; Passon, Max, *Zeit. Angew. Chem.*, 1898, 776-7.

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TRANSPOSITION OF INSOLUBLE SUBSTANCES BY MEANS OF A SODIUM CARBONATE SOLUTION.

By Louis J. Curtman and David Hart.

[*Contribution from the Laboratory of Qualitative Analysis, College of the City of New York.*]

I.—Oxalates.

Introduction:

In nearly all schemes of analysis for the detection of the acid radicals, use is made of a so-called "prepared solution"; by the latter is usually meant a solution obtained by boiling the finely powdered substance to be analysed, with an excess of a sodium carbonate solution. In this manner a solution of the sodium salts of the acids is obtained, which may be analysed without the interference usually occasioned by the presence of the heavy metals. A search of the literature disclosed very little experimental data regarding the extent to which insoluble substances are transposed by a solution of sodium carbonate. It is obvious that until such data are fully supplied, the prepared solution is of questionable value in qualitative analysis.

It was therefore the purpose of this investigation to determine the extent to which the insoluble salts of each of the common acids are transposed by a sodium carbonate solution under definite conditions. The commercial products were used wherever possible because it is these compounds that the analyst is called upon to examine, and not the absolutely pure products which are made in the laboratory.

In this first paper, the insoluble oxalates of the common metals are taken up. Although a careful search was made, nothing could be found in the literature concerning the extent to which oxalates are transposed by a solution of sodium carbonate.

Calcium Oxalate.

Some experiments made some time ago by one (L.J.C.) of the authors, showed that calcium oxalate was not completely transposed by a solution of sodium carbonate. It was therefore decided to use this substance in the preliminary work, the object of which was to determine the most favourable conditions for transposition.

The oxalate content in the grade of calcium oxalate employed throuvhout these experiments, was determined as follows:—Weighed amounts of calcium oxalate were each treated with 20 cc. of (1:1) H_2SO_4 in 500 cc. Erlenmeyer flasks. The mixtures were diluted with water to 400 cc., heated until solution was complete, and titrated while hot with N/4 $KMnO_4$. Our calcium oxalate was found to contain 59.61 per cent. C_2O_4, showing a composition in close agreement with the formula, $CaC_2O_4.10/9H_2O$.

Our next task was to determine the conditions under which a maximum transposition of calcium oxalate could be obtained. In these experiments, 500 mg. of C_2O_4 as calcium oxalate were employed, except where otherwise stated. This amount was used because in systematic analysis it is customary to provide for 500 mg. of acid radical by taking 1 g. of the substance. Throughout this work 3N sodium carbonate solution was used. This was made by dissolving 159 g. of chemically pure anhydrous sodium carbonate in water and diluting the resulting solution to one litre.

To Determine the Effect of Varying the Amount of 3N Na_2CO_3 on the Transposition of Calcium Oxalate, Limiting the Time of Reaction to Five Minutes: Weighed amounts of calcium oxalate each containing 500 mg. or 250 mg. C_2O_4 were boiled with varying amounts of 3N Na_2CO_3 for five minutes in a 250 cc. covered casserole. The mixtures were then filtered and the pre-

cipitates washed until the washings, when acidified with dilute sulphuric acid, no longer bleached a drop of dilute $KMnO_4$. The filtrates were then acidified in 500 cc. Erlenmeyer flasks with 70 cc. (1:4) H_2SO_4, diluted to 400 cc., heated and titrated with standard $KMnO_4$. The results of these experiments are recorded in table I.

TABLE I.

The effect of volume of Na_2CO_3 solution on the transposition of calcium oxalate, keeping the time of reaction constant.

No.	Volume of 3N Na_2CO_3 cc.	P.c. C_2O_4 Transposed using 500 mg. C_2O_4.	P.c. C_2O_4 Transposed using 250 mg. C_2O_4.
1	10	82.56	76.15
2	15	75.12	77.89
3	25	80.70	90.71
4	50	91.30	93.44

Conclusion:

It is evident from Table I. that the best results can be obtained by using 50 cc. of 3N Na_2CO_3. A larger volume was not tried because the impurities in the Na_2CO_3, though usually negligible when small amounts are used, would have to be reckoned with when large amounts are employed. Since, as the above table shows, there is not much difference in the percentage of transposition for 250 mg. and 500 mg. of C_2O_4 as calcium oxalate, it was thought best to use 500 mg. in all other experiments, especially as this is the maximum amount of acid radical which is provided for in systematic analysis.

To Determine the Effect of Time: The above experiments were repeated, varying the time of boiling and keeping the volume of 3N Na_2CO_3 constant at 50 cc.

TABLE II.

The Effect of Time upon the Transposition Calcium Oxalate. Volume 50 cc.

No.	Time Min.	P.c. C_2O_4 transposed using 500 mg. C_2O_4.
1	10	85.94
2	7	88.68
3	5	91.30
4	3	85.57

Conclusion:

Table II. shows that five minutes is the optimum time for the reaction to go to completion.

The results obtained in our preliminary experiments led to the adoption of the following procedure as a general method for the transposition of insoluble substances. About 500 mg. of acid radical as the metallic salt are boiled in a 250 cc. covered casserole for five minutes, with 50 cc. 3N Na_2CO_3. The mixture is then filtered, and the residue washed several times with water. This filtrate constitutes the "prepared solution."

A list of the insoluble oxalates which were experimented with appears in Table III. Before determining the extent to which they were severally transposed by the above procedure, it was necessary that the oxalate content in each case be known. The methods of analysis employed for this purpose are given below. The oxalates were then transposed by the above procedure, and the prepared solutions analysed for oxalate by adding to each 70 cc. (1:1) H_2SO_4, diluting to 400 cc., heating and titrating with N/4 $KMnO_4$. In the case of stannous oxalate, this procedure had to be modified. The modifications are given under stannous oxalate following Table III. The oxalate content of each salt, together with the per cent. transposed, appear in Table III.

Note.—Some experiments were made to determine by the adopted procedure how much calcium oxalate was transposed in a closed system where the volume would remain constant instead of becoming smaller while heating due to loss in evaporation. The experiments were conducted in 100 cc. Erlenmeyer flasks attached to reflux condensers through which cold running water passed. Under these conditions it was found that 88.20 per cent. C_2O_4 as calcium oxalate was transposed.

TABLE III.

Analysis of Insoluble Oxalates and the Extent of their Transposition.

No.	Substance.	P.c. C_2O_4 found by Analysis.	P.c. C_2O_4 Transposed when 500 mg. C_2O_4 are used.
1	Calcium Oxalate	59.61	91.8
2	Barium ,,	38.30	100.0
3	Strontium ,,	43.89	99.1
4	Magnesium ,,	59.91	93.3
5	Ferric ,,	54.61	99.7
6	Ferrous ,,	48.92	98.0
7	Aluminium ,,	41.42	100.0
8	Nickel ,,	45.75	100.0

9	Cobalt	,,	48.37	90.7
10	Manganese	,,	49.18	100.0
11	Zinc	,,	45.99	99.0
12	Lead	,,	29.80	93.5
13	Bismuth	,,	33.43	100.0
14	Copper	,,	56.34	100.0
15	Cadmium	,,	34.35	96.9
16	Stannous	,,	41.42	100.0
17	Silver	,,	27.03	77.5

Methods of Analysis of Insoluble Oxalates: The oxalate content of magnesium, ferric, nickel, manganese, zinc, copper and cadmium oxalates was determined by the same procedure used for calcium oxalate, except that in the case of nickel oxalate a control solution was made by dissolving 1 g. of nickel sulphate in 20 cc. (1:1) H_2SO_4 and diluting the solution with water to 400 cc. It was found that 0.3 cc. of standard N/4 $KMnO_4$ were necessary to produce a decided colour change in this solution, and this amount was therefore subtracted in making the analysis.

A modified procedure was necessary in the determination of the oxalate content of the oxalates of barium, strontium, aluminium, bismuth and silver. The method was as follows: Weighed amounts of the oxalate were treated in 500 cc. Erlenmeyer flasks with 40 cc. (1:1) H_2SO_4 and 160 cc. of water. The resulting mixtures or solutions were boiled vigorously for ten minutes, cooled, diluted to 400 cc., heated and titrated with standard $KMnO_4$.

Ferrous Oxalate.—In ferrous oxalate, the amount of oxalate could not be directly determined as in the above cases since the iron, which was present in the ferrous state, would also reduce the $KMnO_4$. Attempts to oxidise the iron by means of H_2O_4 proved unsuccessful, as shown by our failure to obtain checking results on different charges. The varying results may be accounted for on the supposition that some of the oxalate was decomposed when the solution was boiled to decompose the excess of H_2O_2. The following procedure was found, however, to give concordant results. Weighed amounts of ferrous oxalate were treated separately with 10 cc. (1:1) H_2SO_4 and 90 cc. water, and heated until complete solution took place. To each of the resulting solutions 5 g. sodium acetate were added, the solutions made alkaline with NH_4OH, 2 cc. conc. NH_4OH added to each in excess, the solutions heated to boiling, and treated with H_2S until no further precipitation took place. The mixtures were filtered on fluted filters and the precipitate washed with water containing a little H_2S and sodium acetate. The filtrates were acidified with acetic acid, boiled down to half their volume to expel the H_2S and filtered, when necessary, into 500 cc. Erlenmeyer flasks. To each of the filtrates were then added 70 cc. (1:4) H_2SO_4, the solutions diluted to 400 cc., heated and titrated with standard $KMnO_4$.

Cobalt Oxalate.—Owing to the pink solution which forms when cobalt oxalate is dissolved in H_2SO_4, it is obviously impossible to determine the oxalate content by direct titration with $KMnO_4$ solution, without the preliminary removal of the cobalt. Accordingly the procedure used above for ferrous oxalate was therefore tried and was found to work successfully also in this case.

Lead Oxalate.—In the analysis of this compound, it was found that none of the above procedures gave concordant results. It was therefore necessary to devise a method by which the oxalate content of this substance could be accurately determined. After some experimenting, the following method was found to give uniform results: Weighed amounts of lead oxalate were treated with 25 cc. of water and allowed to stand over night. 20 cc. of 25 per cent. NaOH were added to each, and again allowed to stand over night. The next day the resulting mixtures were boiled for 10 minutes and treated with H_2S until precipitation was complete. The mixtures were then filtered, and the precipitates washed several times with water. The filtrates were acidified with (1:1) H_2SO_4, boiled down to half their volumes and filtered into 500 cc. Erlenmeyer flasks. 70 cc. (1:4) H_2SO_4 were added to each, the solutions diluted to 400 cc., heated, and titrated with standard $KMnO_4$.

Stannous Oxalate. — Considerable difficulty was experienced in the analysis of tin oxalate as well as in the determination of the percentage of this compound transposed by Na_2CO_3 solution. Experiment having shown that stannous oxalate was incompletely decomposed by (1:1) H_2SO_4, it was necessary to dissolve it in HCl preliminary to the removal of the tin by H_2S. After considerable experimenting a procedure was devised by means of which the oxalate content of this compound was accurately de-

termined. The following is a brief outline of the method: Weighed amounts of stannous oxalate were each dissolved in 10 cc. conc. HCl with the aid of heat. The resulting solutions were cooled and diluted to 100 cc. with water. The solutions were then neutralised with NH_4OH, 10 cc. 5N HCl were added, and then treated with H_2S until precipitation was complete. The mixtures were then filtered, the precipitates washed, and the filtrates evaporated to half their original volumes. The filtrates were then made alkaline with NH_4OH, an excess of $CaCl_2$ added, and the mixtures allowed to stand over night. The next day the mixtures were centrifuged at 3,000 R.P.M. After washing with water the precipitates were again centrifuged; the supernatant liquids were poured off, and each of the precipitates dissolved in 20 cc. (1:1) H_2SO_4. The resulting solutions were diluted in 500 cc. Erlenmeyer flasks to 400 cc., heated, and titrated with standard $KMnO_4$.

In determining the percentage of stannous oxalate transposed by sodium carbonate, a special procedure was necessary, due to the formation of some sodium stannite in the prepared solution, which, as is well known, reduces $KMnO_4$. The prepared solution was made just acid with dilute H_2SO_4, and then treated with H_2S until precipitation was complete. After filtering off and washing the SnS, the combined filtrate and washings were evaporated to half the original volume to expel the H_2S completely. To the solution, 70 cc. (1:4) H_2SO_4 were now added, diluted to 400 cc., heated, and titrated with standard $KMnO_4$.

SUMMARY.

1.—Experimenting with calcium oxalate *the most favourable conditions* were determined for the transposition of insoluble oxalates by means of a solution of sodium carbonate. These conditions are applicable in the systematic qualitative analysis for acids.

2.—Insoluble oxalates of nearly all the common metals were analysed for their oxalate content. In special cases, where the oxalate could not be directly determined as in the case of ferrous, cobalt, lead and stannous oxalates, special procedures were devised.

3.—The analysed oxalates were treated by the procedure developed for the transposition of calcium oxalate. The percentage transposed in each case was as follows: Ba, Al, Ni, Mn, Bi, Cu and Sn (ous), 100; Fe (ic), Co., 99.7; Sr, 99.1; Zn, 99; Fe (ous), 98; Cd, 96.9; Pb, 93.5; Mg, 93.3; Ca, 91.3; Ag, 77.5.

New York City, N.Y.

British Empire Exhibition.

(Continued from Page 238.)

L. B. HOLLIDAY & COMPANY, LTD.

In formulating plans for their exhibit at the forthcoming British Empire Exhibition, the firm have departed considerably from the usual plan of dyestuff manufacturers, of illustrating the use of their dyestuffs in colouring the thousand and one things of ornament or utility which fill our modern life. The enormous number of different dyestuffs which a well developed and fully equipped firm manufactures, and the great variety of applications of those dyestuffs, is bound to be bewildering rather than instructive to the lay mind.

The firm have, therefore, concentrated on one idea, and, denying themselves the satisfaction of showing all the beautiful things in silks and leather and printed and woven fabrics of all kinds which can be produced with their dyestuffs, they restricted themselves to providing an ocular demonstration that British made dyestuffs are identical in fastness to exposure with the best foreign dyestuffs.

The exhibit consists in the main of an octagonal showcase, in which the eight sections are occupied by the seven prismatic colours, together with black; and in each section are draped patterns of upholstery, plush dyed with suitable fast-to-light colours, as manufactured in the Holliday works at Huddersfield; together with these dyeings are comparative exposure cards which have been independently and impartially prepared by the Huddersfield Chamber of Commerce, showing the comparative fastness of a dyeing of the Holliday dyestuff, under the same conditions of exposure as an authentic German or Swiss dyestuff of the same nature: in no single case is the comparison to the disadvantage of the British product.

The fallacy that British made dyestuffs are inferior in fastness to foreign made dyestuffs is finally dispelled.

HOPKIN & WILLIAMS, LTD.,

Manufacture a very large range of fine chemicals, and are making a special display of their chemical reagents. They were the pioneers in the British Empire of this branch of the fine chemical industry, their book, "Analytical Reagents," being still the standard work on the subject. They also show a group of uranium compounds for use in the manufacture of pottery, ceramics and glass. Another group of cerium compounds is of interest to the same trades, and also for the tanning and dyeing industries. A full display is made of thorium salts for the use of incandescent gas lighting.

HOWARDS & SONS, LTD.,

Combine an impression of the long standing of the house with their up-to-date methods of manufacture, packing, etc., and the constantly increasing range of their products. The exhibit is housed in a stand built on lines reminiscent of an eighteenth century apothecary's shop, and this atmosphere is enhanced by the display of a number of interestin gold pharmacy jars among the chemicals shown. The firm have endeavoured to show as many typical examples of their very large range of manufactures as space will permit. These examples are, as far as possible, ranged in groups to facilitate reference. With one or two exceptions, no attempt has been made to show specially produced specimens, the exhibits being type samples of the products as *manufactured in bulk. A comprehensive* exhibit of quinine and cinchona products is shown in a great variety of packages as used in different markets. An interesting part of the quinine section is a display showing the relative contents of quinine and other alkaloids of 1 lb. typical cinchona bark of 1870, and 1 lb. typical bark of to-day, illustrating the wonderful strides which have been made during the past 50 years in the cultivation of the tree. Bismuth salts, iodides, mercurials, citrates, camphor and many other products are shown, together with popular trade packages of acid boric, Epsom and Glauber's salts, aspirin tablets, etc., etc.

A special feature of the products of Howards' tableting department is made in the different groups, and there is an interesting separate group showing the stages by which aspirin tablets are evolved from coal. Another group shows the stages by which [illegible] particularly interesting group consists of the new synthetic solvents now being manufactured by Howards', comprising isopropyl-alcohol, cyclohexanol, and many others, which are constantly being added to as the result of work in the research laboratory is transferred to large-scale working in the factory.

THE KALBITUM PAINT COMPANY, LTD.

The firm show a black bituminous paint for iron and steel structural work. Unequalled as an efficient and economical preservative, and used with great success for coating metal work, in electrical storage battery installations, refrigerating plant, gas holders, boiler fronts, ships' holds, bunkers, steel bridges, etc., it is highly recommended for damp walls. The paint is applied cold, and does not require skilled labour.

THE KEYSTONE VARNISH CO., LTD.

The stand is painted and decorated throughout with Keystone specialities. The main exhibit is a large Nature's Harmony Panel decorated in Keystona. A blending of colours showing the beautiful effects and artistic finish obtained in Keystona Flat Oil Paint. Various panels painted with Keystona show ample colour schemes, two-coat work, exhibiting the velvety finish and exceptional body of Keystona. The floor is varnished with Degrah, the varnish for all purposes—water, acid and spirit proof. Quick drying, elastic, durable, and does not show scratches. The *columns and exterior* are painted with Edelvice and Snowflake Enamels, showing the beautiful porcelain finish.

Other exhibits are Zinolin Zinc Paint (Patented), superior in body and covering power to white lead. Unaffected by chemical fumes, gases or sea air. Skiddo, the paint and varnish remover. Gloss Keystona (outside quality), for all exterior work. Lotus Varnish Paint, superior to ordinary oil paint, and gives a finish almost equal to enamel.

B. LAPORTE, LTD.

The firm propose to exhibit:—

Hydrogen peroxide of all strengths, from 10 volumes to 120 volumes, and of various commercial qualities for the bleaching of wool, silk, straw plait, gelatine, etc., etc., also a highly refined and stable quality for medicinal and toilet use.

Barium peroxide, 85 per cent. to 90 per cent. The purest and highest strength made, and the only British make.

Barium carbonate for the prevention of "scum" in bricks, terra cotta, and other ceramics; for purifying water, and for the removal of sulphate of lime from sugar solutions and other liquids; for glass manufacture and various other technical processes.

Barium sulphide, 75 per cent. to 80 per cent., for use as a depilatory and for the dearsenification and purification of acids.

Barium sulphate precipitated, known in trade as "Blanc Fixe," and, in the form of pulp, used in the glazing of paper; employed also as a dry powder in the production of enamel paints, pigments and printing inks.

Formic acid for tanners and dyers.

Barium hydrate, used in the production of milk, sugar, and in sundry other manufactures.

Barium Monoxide, 90 per cent. to 95 per cent.

Sodium hypochlorite.

Sodium pyrophosphate.

Sodium acid pyrophosphate; an ideal aerating agent for use by bakers and confectioners.

Sodium sulphide, crystals and concentrated, for use in tanning, dyeing, and in the manufacture of sulphur dyes.

Sodium bisulphite in powder and solution.

Sodium perborate, containing 10.4 per cent. of active oxygen, a powerful antiseptic and bleaching agent.

Laundry requisites, including dry soaps, soft soaps, washing powders, preparations for whitening and removing stains; blues, etc., etc.

Sundry proprietary and special preparations for various technical and trade purposes.

(To be continued.)

PROCEEDINGS AND NOTICES OF SOCIETIES.

THE ROYAL INSTITUTION.

A General Meeting was held on April 7, Sir James Crichton-Browne, Treasurer and Vice-President, in the chair. The Secretary reported the death of Dr. Donald [illegible], a former Manager and Vice-President, and a resolution of condolence was passed. The Duchess of Bedford, Dr. Borns, Dr. J. C. Crocker, Mrs. Adams Frost, Mr. A. P. Griffiths, Sir Samuel Instone, Dr. David T. MacLeod, Mr. Stephen Miall, Sir Humphry Davy Rolleston, Mr. James H. Scrutton, Sir John Simon, P.C., Miss Florence Stawell, Mr. Arthur Taylor and Lady Webb were elected members.

SOCIETY OF PUBLIC ANALYSTS AND OTHER ANALYTICAL CHEMISTS.

ORDINARY MEETING, APRIL 2.

Mr. G. Rudd Thompson, President, was in the chair.

The following were elected members of the Society:—Messrs. Philip Walter Alloway; Lorentz Oliver Brekke, B.Sc. (Leeds), A.I.C.; Alex Munro Cameron, B.Sc., F.I.C.; Thomas William Drinkwater, L.R.C.P., L.R.C.S. (Edin.), F.I.C.; John Ralph Furlong, Ph.D. (Wurzburg), A.I.C.; Ernest Griffiths-Jones, M.Sc. (Manch.), A.I.C.; Basil Gordon McLellan, F.I.C.; William Thomas Rigby, F.I.C.

Papers read:—

A Report on the World's Dairy Congress, held at Washington, D.C., U.S.A., by JOHN GOLDING, D.S.O., F.I.C.

A brief account was given of visits to laboratories, universities, etc., in New York, Washington, Ithaca, Guelph, etc. Reference was made to papers communicated at the meetings at Syracuse on recent discoveries in the newer problems of nutrition. Among these, papers by H. M. Evans on the dietary factor essential for reproduction were mentioned.

Causes of vitamin variation in milk, Kennedy and Dutcher, etc.

Value of milk as a cure for deficiency diseases, E. V. McCollum and La Fayette, B. Mendel and H. C. Sherman.

Vitamins and calcium balance in cows, E. B. Forbes, E. B. Meigs.

Other subjects included the use of milk in broad-making, and the necessity for legislative control.

The Routine Examination of Dairy Products, with Special Reference to the Mojonnier Tester, by T. H. LAMPITT, D.Sc.

F.I.C., E. B. Hughes, B.Sc., F.I.C., and M. Bogood, B.Sc., A.I.C.

The Mojonnier tester for the determination of total solids of milk consists of a hot plate on which the milk is evaporated in an aluminium dish, and an electrically heated and thermostatically controlled vacuum oven, in which drying is completed, the dish being cooled off in a water-cooled desiccator. The time for a complete determination of total solids in milk is 21 minutes.

The Mojonnier method for the determination of fat is a modified Röse-Gottlich method. The extraction is carried out in a specially shaped flask, which can be shaken vigorously after the addition of each reagent, and then centrifuged.

The ethereal layer is decanted into an aluminium dish, evaporated on a hot plate, dried in a vacuum oven, and cooled in the desiccator. The time for a complete determination of fat is 30 minutes, or for total solids and fat together, 38 minutes.

Typical results were shown for these determinations on various milk products.

An application of the Gerber method to the determination of fat in milk powders was advocated.

Experiments on the Absorption of Copper following the Consumption of Vegetables containing Copper Sulphate, by J. C. Drummond, D.Sc., F.I.C., Miss M. G. Palmer, B.Sc., and Miss D. E. Wright, B.Sc.

Metabolism experiments have been made on rats maintained on diets containing a high proportion of peas containing added copper. As recorded by previous observers, most of this copper is not absorbed, but is excreted by the alimentary tract. Definite evidence was obtained that some small proportion of the copper may be absorbed into the blood. This absorbed copper may be in part retained for a time by the liver, and is excreted by the kidneys. Rats maintained for two to three months on diets containing a high proportion of copper-peas showed normal growth and health. Close examination of the tissues at the end of the experiment showed no abnormality which could be attributed to the copper absorbed from the food.

An Attemp tto Extend Mitchell's Colorimetric Method to the Catechol Tannins, by Phyllis Honor Price, B.Sc. (Work done under the Analytical Research Scheme.)

Mitchell's ferrous tartrate reagent can be used for the colorimetric comparison of (1) catechol with catechol; (2) protocatechuic acid with protocatechuic acid; and (3) catechin with catechin, but the method does not give satisfactory results for the comparison of these substances with one another. The ratio between the colorimetric results is not a molecular one, as observed by Mitchell in the case of pyrogallol and gallic acid, where the carboxyl group acts as a diluent. It was found that catechol tannins, unlike pyrogallol tannins, are precipitated by the combined action of the reagent and quinine hydrochloride or cinchonine sulphate, and this behaviour prohibits the application of the method to catechol tannins. A series of experiments has shown that in order to give the violet coloration with the reagent, a substance must contain two hydroxyl groups in the *ortho* position.

GENERAL NOTES.

AMERICAN CHEMICAL EXPOSITION IN 1925.

The Tenth National Exposition of Chemical Industries will be held in New York, from September 28 to October 3, 1925, and will be the most extensive chemical and scientific exposition ever held in the United States. The aim is to secure over 500 exhibitors, the largest previous record for the American Chemical Exposition being 425. Although representatives of industries outside the United States have always been present at former Chemical Expositions, efforts will be made to increase the number of foreign buyers of industrial chemicals and chemical equipment. The 1925 Exposition will be America's biggest offer of the products of her chemists and engineers to industry all over the globe.

A constant expansion in the type of products shown at the Chemical Exposition has been noted from year to year. Chemicals, from the heaviest type of industrial product down to the finest of synthetic aromatics; dyestuffs; equipment, including every type of chemical engineering apparatus with the latest developments; engineering instruments; accessories, such as the newer things in barrels, carboys, tanks, drums, automatic weighing and filling machinery, acid-proof floorings, and mr.

merous others: these make up the main body of products which will be on display. The materials on exhibition will be the output of some 500 companies from the largest organisations in the country to some of the smaller specialists.

In conjunction with the Exposition, many American chemical and associated scientific societies will hold meetings. Technical men will meet with the executive and sales forces for discussions of production and distribution problems. Lectures and motion pictures on chemical subjects, or on the chemical consuming industries, given by prominent authorities, will be a part of the programme. One of the big features will be a one-week intensive course in practical chemical engineering for a thousand students of chemistry and chemical engineering from the colleges. Leaders in the various fields of chemical engineering practice in the United States will conduct the short course for the students. A glimpse into the business side of their profession is the plan of the special gathering of students. A series of educational exhibits, showing various phases of the newer chemical developments, and the application of chemistry to the solution of numerous industrial problems, are to be worked out on a broad scale.

The management, which has conducted every Chemical Exposition in the United States since the beginning in 1915, will again be under the International Exposition Company, New York, with Charles F. Roth and Fred W. Payne as co-managers. They are located in the Grand Central Palace, New York.

THIRD CENSUS OF PRODUCTION.

In accordance with Section 9 (1) c. Census of Production Act, 1906, the President of the Board of Trade has appointed the following gentlemen, together with officials of the Home Office and the Board of Trade, to be a Committee for the purpose of advising the Board as to the preparation of the forms and instructions necessary for the taking of the census, and the making of any rules under that Act:—

Mr. T. J. Arnold, J.P., Sir Arthur Balfour, K.B.E., Sir Hugh Bell, Bart., C.B., Professor A. L. Bowley, Mr. Stephen Easten, O.B.E., J.P., Sir Henry J. Gibson, K.C.B., Mr. Kenneth Lee, Professor D. H. Macregor, Mr. R. C. Perry, C.B.E., Sir W. Peter Rylands, Mr. Arthur Shaw.

The Committee will hold its first meeting at an early date.

The Secretary of the Committee is Mr. G. A. G. Stanley, Board of Trade, Great George Street, London, S.W.1, to whom all communications should be addressed.

Board of Trade,
April 8, 1924.

The following statement was made at the recent dinner of the Institution of Mining and Metallurgy by Mr. W. S. Robinson, a Director of the National Smelting Co., Eectrolytic Zinc Co. of Australasia, Broken Hill Associated Smelters, and Zinc Producers' Association Pty., Ltd., and a member of the Burma Corporation Advisory Committee:—

"From 1906, when the commercial production of zinc concentrates may be said to have started at Broken Hill, N.S.W., about 14,000,000 tons of zinciferous residues have been treated. From them, 4,000,000 tons of zinc concentrates were produced, representing nearly 1,500,000 tons of spelter, and 4,000,000 tons of sulphuric acid. Nearly 75 per cent. of this vast quantity went to the Continent of Europe for treatment in Belgium, France, Germany and Holland. After about the middle of 1925 the Continental trade will entirely cease, and all concentrates will be treated in the British Empire. I believe that as a result of this policy a new era will be oepned not only for the British mineral and metal industries, but for the acid chemical and allied trades also, if those interested are but prepared to take advantage of what is now offering."

NOTICES OF BOOKS.

The Theory of Relativity, by ERWIN FREUNDLICH, Translated by HENRY L. BROSE, M.A. Pp. XII. + 98. London: Messrs. Methuen & Co., Ltd., 36, Essex Street, W.C.2. 1924. 5s. net.

This volume is a translation of two lectures on the special and the general theories of relativity, together with the matter of a preliminary lecture on Newtonian mechan-

ics, delivered by Prof. Freundlich to an audience of chemists.

Like most scientific matters of importance, the theory of relativity requires careful reading, and much hard thought in order to be thoroughly understood. The present volume has the advantage over many other popular books on the subject, that it was prepared more particularly for the benefit of chemists. The author also has in mind that scientists engaged in one domain have little leisure to devote to a mastery of the recent and contemporaneous developments in branches other than their own.

Viscount Haldane has contributed an appreciative introduction, and the book can be strongly recommended to all whose ideas on the subject are still vague.

Official Chemical Appointments, compiled by THE REGISTRAR OF THE INSTITUTE OF CHEMISTRY. Pp. XII. + 311. Fifth Edition. London: The Institute of Chemistry of Great Britain and Ireland, 30, Russell Square, W.C. 1924.

This volume provides a complete list of the Official Chemical Appointments in the British Empire. Part I. gives those for the British Isles, and Part II. includes the rest.

This information has been compiled by the Registrar of the Institute of Chemistry, whose task has been a formidable one. This will be realised when it is recalled that the previous edition appeared as long ago as 1912.

The lists are arranged in divisions, giving the appointments under the various Government Departments, County and Borough authorities, Colleges, Technological Institutes, and Public and Secondary Schools.

In addition to strictly chemical appointments mention is made of many positions connected with agriculture, metallurgy, mineralogy, bacteriology, etc., in which chemical knowledge and skill are needed.

One appendix gives concise information concerning chemical and scientific societies, and another gives the conditions of appoint-

New Patents.

THIS list is specially compiled for *The Chemical News* by Messrs. Rayner & Co., Registered Patent Agents, of 5, Chancery Lane, London, from whom all information relating to Patents, Trade Marks, and Designs can be obtained gratuitously.

Latest Patent Applications.

7427—Coley, H. E.—Reduction of carbonates or bicarbonates. March 24.
8048—Cutter, J. O.—Process for manufacture of active absorbing carbon and phosphoric acid and its compounds. March 29.
7484—Kassner, G.—Manufacture of nitric acid, etc. March 24.

Specifications Published this Week.

212768—Sulfur Akt-Ges, and Franck, Dr. W.—Process and apparatus for the manufacture of sulphuric acid.
209706—Soc. Chimique des Usines du Rhone.—Process for the preparation of diethyl chloracetamide.
198676—Durand & Huguenin Akt-Ges.—Manufacture of highly chlorinated hydro-aromatic products containing nitrogen.

Abstract Published this Week.

210809—Synthetic drugs. — Farbwerke vorm. Meister, Lucius & Bruning, Hoechst-on-Main, Germany.

Compounds having soporific properties are prepared by reacting with a heavy metal upon an α-halogen fatty acid of the formula

$$\begin{matrix} R \\ R \end{matrix} > CX\text{—}COOH$$

(where R = alkyl and X = halogen) or a derivative thereof, such as an ester or a nitrile, or upon a mixture in molecular proportions of the said compound with a halogen alkyl, and converting the product in either case into the corresponding amide. According to the examples, (1) diethylbromacetonitrile is boiled in xylene with copper powder; tetraethylsuccinic acid nitrile is produced, which, on treatment with sulphuric acid, forms the diamide; (2) bromodiethylacetic acid ethyl ester under the same conditions as in (1) yields tetraethylsuccinic acid ethyl ester, from which the same diamide as before is obtained by heating with alcoholic ammonia; (3) a mixture of diethylbromacetonitrile and allyl bromide, when heated in toluene with copper powder, forms diethylallylacetonitrile, which gives diethylallylacetamide on heating with alcoholic caustic alkali.

Messrs. Rayner & Co. will obtain printed copies of the published specifications and abstract only, and forward on post free for the price of 1s. 6d.

THE CHEMICAL NEWS,

VOL. CXXVIII. No. 3341.

AN EXPLANATION OF THE THEORY OF THE ROTATION OF THE ATOMIC NUCLEUS.

PART VI.

By HERBERT HENSTOCK.

ORGANIC CHEMISTRY.

It is impossible in the small compass of these papers to attempt a systematic survey of the subject as applied to organic chemistry; it is therefore proposed to examine a few of the more interesting cases taken at random from various parts.

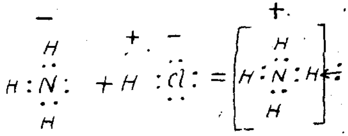
Since his enunciation of the theory of the induced alternate polarities of atoms, Lapworth has already described its application to many organic compounds (*Mem. Manchester Phil. Soc.*, 1920, LXIV., 1-17; *Trans.*, 1922., CXXI., 416, and elsewhere), and this has been extended and applied to specific cases by Kermack and Robinson (*Trans.*, 1923, CXXI., 427), by Robinson (*Mem. Manchester Phil. Soc.*, LXIV., 17), by Lowry (*Trans.*, 1923, CXXIII., 822), and by others who are specially interested in the subject, or who have applied the theory to the elucidation of some problem connected with their own particular sphere of work.

By the application of the principles, already described in *The Chemical News* (1923, CXXVI., 129), and in the earlier parts of this series, to the hydrocarbons and their more stable compounds the various linkages may be easily worked out. These principles, based firstly upon the Lewis-Langmuir electronic theory of valency, which grew out of the discoveries of J. J. Thomson, and secondly upon Lapworth's theory of the induced alternate polarity of atoms, are put forward as an attempt to bring these two theories into closer accord, and also as an attempt to extend the latter theory by suggesting a cause for alternate polarity, which cause, in its application, might explain certain difficulties met with in that theory. In explaining this extension (*i.e.*, the theory of nuclear rotation) the author may have stated what, in some cases, appear like revolutionary opinions, which ignore established views based on facts or analogies. There is, however, a cause for such s[...] have not been made without due consideration: in some cases they are stated as genuine attempts at explaining some hitherto obscure point, but in most cases with a view to eliciting information as to the views of others upon such points.

THE ALIPHATIC SERIES.

An example of the latter is the formula suggested for ammonium chloride in Part II. The difficulty here encountered is as follows:—It is well known that ammonium hydroxide is a weaker base than tetra methyl ammonium hydroxide; this fact may be put down to the cumulative effect of the methyl groups upon the nitrogen atom. On the other hand, in the preparation of ammonium hydroxide, the neutral substance, water, is employed, whereas in that of the tetra methyl compound the electrolyte, AgOH, is used, *i.e.*, the halide replaced is already an ion.

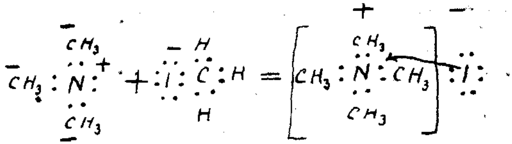
Again, when ammonia and hydrochloric acid unite, we have

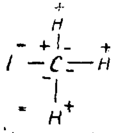


The hydrogen of the HCl has already given up its electron to the chlorine before the union takes place. The question is, "Does the hydrogen take back its electron from the chlorine and pass with it to the nitrogen, which then gives up one of its electrons to the chlorine to form an electrovalence direct between the two?" If this is so, there seems to be a great bandying about of electrons, and also it seems unlikely that the nitrogen of ammonia is strong enough to force the hydrogen of the HCl to reclaim this electron from the more permanently negative chlorine.

If this is not the case, then it is suggested that the chlorine is still attached to the hydrogen, and that this intervening hydrogen atom constitutes the weakness of the ammonium compounds.

When trimethyl amine and methyl iodide unite, we have





constitution of CH_3I.

i.e., tetra methyl ammonium iodide is not formed on adding an *electrolyte* to tri methyl amine. The methyl iodide, not being an electrolyte, has co-valencies only, and when the one between iodine and CH_3 breaks, the former presumably goes with its seven electrons to the nitrogen, from which it takes an electron to form an electro-valence direct, and thus leaves a fourth co-valence - bond in the nitrogen octet, to which the methyl group joins up.

Tetra methyl ammonium hydroxide is seen in Fig. 1.

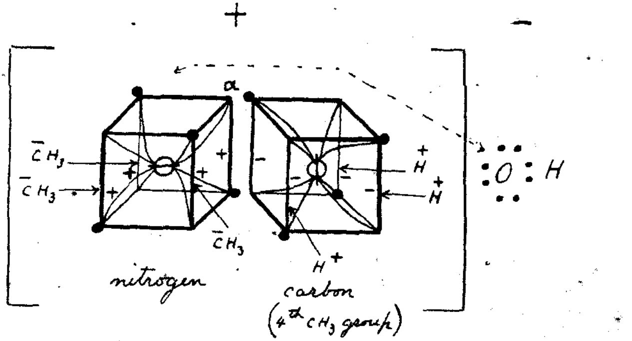


Fig. 1.

The nitrogen has given up the electron at (a) to the oxygen to form the electro-valence, so that the OH group is attached directly to the nitrogen, the positive polarity of which is very greatly enhanced. Here there is no intervening hydrogen atom between nitrogen and oxygen; the fourth CH_3 group is attached to the nitrogen by a similar bond to those by which the other three are linked, consequently this type of compound is much more stable and basic than ammonium hydroxide, and is as strong a base as the alkaline hydroxides. Werner (*Lehrbuch der Stereochemie*, p. 309) was of

opinion that the fourth hydrogen atom, in simple ammonium salts, is linked to nitrogen differently from the other three. He *imagined the nitrogen atom to be situated* in the centre of a cube; thus:

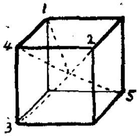


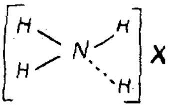
Fig. 2.

The bonds to 1, 2 and 3 being those of trivalent nitrogen, 4 and 5 the two extra ones of pentavalent nitrogen. He says:—

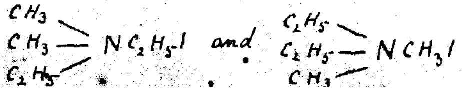
"Aus dieser Figur ist ersichtlich, dass die Valenzpunkte 1, 2, 3 gleichwertig, 4 und 5 aber von, 1, 2, 3 und auch unter sich verschieden sind, und zwar wird die Verschiedenheit der Valenzen 4 und 5 vorausgesetzt, weil das Ammoniak sich nicht mit 2 Wasserstoffatomen oder zwei Chloratomen verbinden kann."

On page 310 he says:—

". . . ., nimmt die Formel der Ammoniumsalze folgende Gestalt an":



clearly showing that he considered the fourth hydrogen differently linked. At the same time, he thought that this also applied to the quaternary alkyl ammonium salts, but this can hardly be the case, since di-methyl-di-ethyl ammonium iodide obtained from di-methyl amine and ethyl iodide, as well as from di-ethyl amine and methyl iodide, show no difference in properties or composition, and therefore the two products are identical: as



the four nitrogen bonds are equivalent; compare Le Bel (*Bull. Soc. Chim.*, 1891, II., 305; *Ber.*, 1891, XXIII., 147; *Annalen*, CLXXX., 173). This is then a real difficulty, and if the explanation of it, put forward both here and in Part II., is not in accordance with the facts, and is therefore unacceptable, we are still in a position of uncertainty concerning it.

Some of the rules which were found to hold in the inorganic chemistry, as between atoms which differ widely in permanent tween atoms which differ widely in permaany other atom or group, which replaced the nent polarity. A double bond is a combination of positive and negative bonds, so that carbon atoms linked by such bonds are neither wholly positive nor wholly negative. In a chain containing a double bond the polarities on either side of it need not necessarily make alternate polarities throughout the whole chain: for instance, in propadiene, when each linkage is labelled, we have

$$\overset{+}{H_2} - \overset{-\ \mp}{C} = \overset{\pm\ \pm}{C} = \overset{\mp\ -}{C} - \overset{+}{H_2}$$

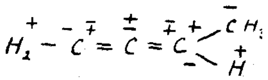
The central carbon is united equally by positive and negative bonds, and on this account is neutral in alternate polarity, so that, written simply, it would be

$$\overset{+}{H_2} - \overset{-}{C} = \overset{+}{\bar{C}} = \overset{-}{C} - \overset{+}{H_2}$$

$$\quad + \quad - \quad + \quad - \quad +$$

(but not $H_2 - C = C = C - H_2$).

The two-end carbon atoms are united on one side by a double bond $\pm$, but on the other by two negative bonds each. They therefore exhibit negative alternate polarity to the hydrogen atoms. If a negative group such as $-CH_3$ joined an end-carbon atom, it would link with one of the positive bonds of that atom, which would then become positive to such a group as



And since such a negative group is stronger in polarity than the remaining hydrogen atom, the carbon atom to which both are any other atom or group which replaced the hydrogen, by a positive edge than by a negative one, hence its alternate polarity is attached would be more likely to unite with positive for this bond also: the second hydrogen on replacement by methyl gives

$$\overset{+}{H}_2 \overset{-}{-} \overset{\mp}{C} = \overset{\pm}{C} = \overset{\mp}{C} \begin{matrix} \overset{+}{\diagup} \overset{-}{C}H_3 \\ \underset{+}{\diagdown} \overset{-}{C}H_3 \end{matrix}$$

It will be seen that the alternate polarity does not cross the double bonds. If the alternate polarity does cross a double bond it would depend on the strength of the key atom as to whether the polarities across the bond were strong or weak, but alternate polarity will not cross two double bonds, for on addition of one molecule of HBr we have

$$\overset{+}{H}_2 \overset{-}{-} \overset{\mp}{C} = \overset{\pm}{C}\overset{-}{H} - \overset{+}{C}\overset{-}{Br}(\overset{-}{C}H_3)_2$$

the bromine attacking the already positive carbon in preference to the end negative one, and it is only on addition of a second molecule of HBr that the latter is attacked. See Mokijewski (*Centralblatt*, 1900, 331.)

(*To be concluded next week.*)

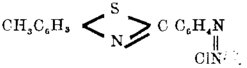
STUDIES IN THE REACTIONS OF THE AMINO GROUP IN 4′ AMINO 1 PHENYL 5 METHYLBENZOTHIAZOLE.

PART 7.—THE REDUCTION OF 1 PHENYL 5 METHYL BENZOTHIAZOLE 4′ DIAZONIUM CHLORIDE BY MEANS OF STANNOUS CHLORIDE.

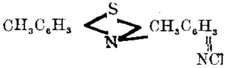
By R. F. HUNTER, F.C.S.

4′ Amino 1 phenyl 5 methylbenzothiazole or dehydrothioparatoluidine, when dissolved or rather made into a suspension of its hydrochloride with hydrochloric acid, is readily diazotised to a mixture of syn and anti forms of the diazonium chloride (1 and 2) by means of either ethyl, amyl or sodium nitrite. The syn and anti forms of the diazonium compound were isolated by Morgan (*J.C.S.*, 1921, CIXX., 1070), who prepared a number of derivatives from these.

4′ Diazonium 1 phenyl 5 methylbenzothiazole represents one of the stablest diazonium compounds which so far have been isolated. Thus, when the syn and anti forms are isolated they can be kept for any length of time at ordinary temperatures.



(1)

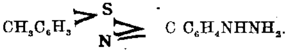


(2)

In part 6 of this series of papers (*loc. cit.*) the diazonium compound was prepared and coupled with resorcinol to form a typical azo dye of the thiazole type, the phenol, that is, 4′ hydroxy 1 phenyl 5 methylbenzothiazole and the diazoamino compound of dehydrothiotoluidine were also prepared from the diazonium solution by the usual reactions.

It is well known that when diazonium benzene hydrochloride, prepared by the careful diazotisation of aniline, is reduced with stannous chloride in excessive quantities in concentrated hydrochloric acid, that phenylhydrazine, or, to be more accurate, the hydrochloride of the latter, separates, from which the free base is obtained by the addition of caustic soda, after the neutralisation of the free acid.

It occurred to the author that in view of the stability of the diazonium compound of dehydrothiotoluidine that it might be possible, by reducing with stannous chloride under suitable conditions, to prepare a hydrazine of dehydrothiotoluidine, that is, a hydrazine containing the dehydrothiotoluidine residue of the formula (3).



(3).

The diazonium chloride was therefore prepared as described in the experimental part of this paper. To the solution cooled in ice was then added a strong solution of stannous chloride in concentrated hydrochloric acid. In the proportions given, the first drop of stannous chloride solution pro-

duced an immediate orange precipitate, and this increased with the addition of a further quantity of the reducing agent. The beaker and the contents were allowed to stand for twenty minutes or more in the freezing mixture. At the end of this time, the orange precipitate, which was remarkably bulky, was filtered, and washed with cold distilled water, and the filter allowed to drain for two or three days. The precipitate retains a remarkably large amount of moisture, even after being allowed to drain over a considerable period of time. After several days the precipitate was removed, placed between filter papers and left to dry. Owing to the fact that other experiments were in progress at this time, the substance was left to dry on a pad of clean blotting paper for a period of six weeks or so. At the end of this time it was found that the substance had become a dark red paste, the bulk of which was considerable, since only four gms. of the 4′ amino 1 phenyl 5 methyl benzothiazole had been employed in the preparation.

It was thought that the product of the reduction had in all probability formed an addition product with the excess of stannous chloride present. If this were so it was reasonable to suppose that the stannous chloride could be dissolved out by a large excess of caustic soda solution. At the same time the free base would be liberated. On warming a small portion of the red reduction product with an excess of caustic soda, the colour changed to an ochre tint. If caustic soda is slowly added with shaking a variety of colour changes between deep red and pale yellow, ochre can be observed, the final product being ochre in its tint.

The whole of the pasty product obtained above was therefore stirred into some 200 ccs. of 2N sodium hydroxide. A peculiar odour, reminiscent of a nitrogen heterocyclic such as quinoline, was noted during this stirring. A vermilion rather gritty precipitate settled out; and the solution assumed a yellow orange colour. The beaker was left for a couple of hours at room temperature, for the decomposition to complete itself. At the end of this time another 100 ccs. of sodium hydroxide were added, and the beaker warmed on a sand bath for some time when the solution and precipitate assumed the ochre colour. The solution was then filtered hot through a large funnel. A clear and nearly colourless alkaline filtrate results. The precipitate on the filter paper assumes a slimy colloidal form which was washed only with considerable difficulty. The substance appears to be homogeneous.

The filtrate should then contain any stannous chloride in the form of sodium stannite which was originally present in the red substance. A portion of the filtrate was therefore acidified with hydrochloric acid, and hydrogen sulphide passed through the solution with negative results. This was repeated, using a larger bulk of filtrate, with negative results. Another portion was then acidified with strong hydrochloric acid and added to freshly prepared solution of mercuric chloride. There was no precipitate, clearly indicating the absence of tin. It was thought that the precipitate might contain tin, and therefore a small portion was taken and boiled with concentrated hydrochloric acid. A yellow orange rather cloudy solution resulted, which was filtered and treated with the mercuric chloride solution again with negative results. During the warming of the above substance with acid, it was noted that a red insoluble substance was left in the tube. This was separated, washed with water, and warmed with ethyl alcohol. Partial solution took place with the production of a light chrome solution exhibiting fluorescence. A portion remained undissolved, and was not induced to go into solution by adding further alcohol and boiling. Pouring the alcoholic extract into cold water produced a light chrome flocculent precipitate, unlike the rather tarry yellow substance resulting on treating an alcoholic solution of dehydrothiotoluidine in a similar manner.

The product obtained by digesting the original red paste of reduction product is much smaller in bulk, in fact, the yield is of the quantity to be expected, the bulkiness of the red substance is clearly to be attributed to adsorbed hydrochloric acid which the original precipitate retains even after draining for several days. This also accounts for the large amount of sodium hydroxide taken to liberate the free yellow base (about 200 to 300 ccs.). The substance obtained by the stannous chloride reduction of diazonium dehydrothiotoluidine is clearly a base which differs from dehydrothiotoluidine in having a bright red hydrochloride.

When dehydrothiotoluidine is treated with hydrochloric acid we have isomerisation of benzenoid to quinonoid form with the change of colour from pale yellow to a bright brown. Similarly, in this case, we

have benzenoid quinonoid isomerisation with the change from yellow ochre to bright red colour.

If the base which has been isolated has the formula (3), it will form an attractive compound for study, particularly owing to the variety of condensation products which could be obtained from such a structure. The compound is therefore being studied further with this object in view. For instance it would be particularly fascinating to find whether a hydrazine containing a six-membered homocyclic five-membered sulphur nitrogen heterocyclic fused ring system, such as the benzothiazole residue in dehydrothiotoluidine was capable of condensing with sugars to form compounds analogous to the phenylhydrazones; here clearly the benzothiazole system will have a considerable effect on the hydrazine part of the molecule, the obvious effect being a decrease in reactivity.

EXPERIMENTAL.

Dehydrothiotoluidine:

This was worked up, as has already been described by the author (*Trans. Soc. Chem. Ind.*, 1923, XLII., 302).

Diazonium Chloride:

4 gms. of dehydrothiotoluidine are mixed with 100 ccs. of concentrated hydrochloric acid. The beaker is cooled to zero Centigrade in a mixture of ice and salt. The theoretical sodium nitrite in ice water is then added slowly with stirring. A deep brown clear solution of 4′ diazonium 1 phenyl 5 methyl benzothiazole results.

Reduction:

20 gms. of stannous chloride are dissolved in 20 or more ccs. of concentrated hydrochloric acid and the solution cooled. The stannous chloride is then run in slowly from a tap funnel, with steady stirring, into the diazonium solution kept in the freezing mixture. An orange brown precipitate separates out with the addition of the first drop of reducing solution. When all the stannous chloride has been added, the beaker is left in the freezing mixture for another twenty minutes or more.

The precipitate is then filtered through a large filter funnel, and the funnel allowed to drain for several days. The precipitate, which is pasty and orange in colour, is removed, and allowed to dry between filter papers for several days. The product is rather pasty and a bright-red colour after preserving for some weeks.

The Free Base:

The product obtained above is stirred into 200 ccs. of 2N sodium hydroxide in a beaker, and the beaker and contents left for two hours or so at room temperature to allow the decomposition to take place and the red precipitate to orm. At the end of this time another 100 ccs. of caustic soda are added, and the solution warmed for some time on a sand bath. The hot solution, which is ochre yellow, is filtered hot through a large funnel and the precipitate washed with water on the filter paper. The free base is yellow ochre in colour, as produced above is colloidal in form, and difficult to wash.

Examination:

Bot hthe solid and the filtrate give negative tests for tin. The hydrochloride of the substance is bright red in colour. On warming, partial solution of the product takes place. The alcoholic solution is bright chrome and fluoresces and yields a bright yellow flocculent precipitate on pouring into water. The residue which does not dissolve in hot alcohol is red in colour.

The Chemical Laboratory,
Highbury New Park, N.5.
March, 1924.

British Empire Exhibition.

PARTICULARS OF EXHIBITS.

(*Continued from Page* 253.)

LEVER BROS., LTD.

Messrs. Lever Bros., Ltd., whose name is famous throughout the civilised world, will not only show all their well-known products, but also will place much interesting and valuable information regarding the use of numerous soaps, cleansing agents, etc., at the disposal of the public. Experts will be present to explain and to guide and advise all who are interested.

Sunlight Soap.—The English word Sunlight immediately arouses a picture of homes made happier by Sunlight Soap, without doubt one of the greatest boons ever conferred on housewives. Sunlight Soap will of course form a prominent part of Lever Brothers' display, as also will be the following products, to which we can only refer briefly in this place.

Lifebuoy.—The great health soap, Lifebuoy, follows Sunlight Soap very closely in popular esteem; the familiar figure of the lifeboatman with which it has always been identified, has become a symbol of wise precaution against dirt and disease.

Lux.—The celebrated soap product in delicate flakes on which housewives have long relied for the washing of flannels, woollens and fine fabrics, will also be on view.

Twink.—Whenever a dye is mentioned, Twink inevitably suggests suggests itself as the preparation which is capable of giving colour to silks, cottons, linens and woollens. The wide range of Twink colours will be shown by a novel mechanical device.

Vim and Others.—Vim, the best known cleanser and polisher, will be there, too, and also Monkey Brand, Comfort, the Palm and Olive Oil Soap, Kit, the soap for greasy and grimy hands, Swan, the famous white floating soap. Gilt Edge Soft Soap, "Old Home" Soap, Plantol Natural Bouquet Soap, Starlight, Velvet Skin Soap, Melody, Coral, Zulu and Lever's Easy Shaving Stick. All these essentials of modern life will be on view, and helpful points concerning them will be available.

On the same stand, Messrs. R. S. Hudson's will exhibit their products, including the famous Hudson's Soap, Rinso, Omo, Longa Life.

In the centre of the stand there will be a large revolving centre-piece, containing photographic illustrations of Port Sunlight, that ideal industry township which is so important a feature of North English life, and so valuable a part of a great industry.

THE NOLABO POLISH CO., LTD.

All interested in labour saving are invited to visit this stand, where a demonstrator is at work showing the easy method of applying "Non-Slip" Floor Polish. It requires no rubbing. Simply spread the liquid on and the gloss appears. "Nolabo" Silver Polish—for every home and garage—reduces to a minimum the work of cleansing silver plate, brass and aluminium.

THE OFOME COMPANY.

The exhibit consists solely of a standardised cleanser, Ofome, specially designed to combine the uses of soft soap, household soap, cleaning powders and benzene, and to reduce the cost and labour of cleaning by eliminating waste and the overlapping of various preparations. The firm claim to have put household and general cleaning on a new and scientific basis, without risk of damage.

J. J. RIGBY, LTD.

The exhibits will include hard and soft soaps.

Soft Soap.—A pure vegetable oil potash soft soap. This soap is widely used by waste spinners. It is guaranteed pure.

Hard Soaps.—1: Soaps for textile works. Pure vegetable oil soap, specially suitable for scouring and milling, and also for silk washiug. 2: Soaps for household use.—(i) Rigby's Marvellous Cleanser. A hard nonwasting soap made from vegetable oils. May be used for toilet purposes. (ii) Rigby's Honey Soap. A household soap for general use. No excess alkali. Guaranteed pure and free from adulterants. (iii) Rigby's Greenolive Soap. A soap which is being extensively used for toilet purposes and for washing fine lingerie and silks. Contains olive oil and other vegetable oils—no animal fat.

In addition to the finished products, the firm show specimens of the raw materials used and the various stages in soap manufacture.

EUGENE RIMMEL, LTD.

The exhibit consists exclusively of high-class perfumes and all articles appertaining to the toilet.

PETER SPENCE & SONS, LTD.

This firm, who have been well known all over the world as manufacturers of alum, etc., for nearly 80 years, show specimens of various qualities of alum, aluminium sulphate, and other inorganic salts of aluminium, and of their manifold applications in the mordanting and dyeing of textiles, paper-making, leather manufacture, fire-proofing, drinking water purification, sewage precipitation, etc.

A beautiful feature of this exhibit, and one which should not be overlooked, particularly by anyone interested in crystallography, is a wonderful display of a comprehensive range of practically perfect crystals of various alums, all of them regular octahedra in shape, illustrating their isomorphism, and including one huge crystal weighing over 200 lbs., which took nearly four years to grow, and is probably the largest single artificial crystal of any substance ever produced.

Flanking this exhibit are two large pyramidal columns, over five feet in height, each of which is built up of over 130 practically perfect octahedral alum crystals of various sizes, the largest of which took nearly two years to grow.

Another section of the exhibit is mainly devoted to this firm's well-known Titanium specialities, including those extremely powerful reducing and stripping agents, Titanous Chloride and Titanous Sulphate, and the Titanium Potassium Oxalate so largely used in leather dying, with examples of their industrial application.

Messrs. Spence also show other materials of which they are large producers, such as sulphuric acid (pure brimstone and B.O.V. grades), carbonate of lime, and silica powder, etc.

J. & E. Sturge, Ltd.

Will show:—

1.—*Precipitated Chalk*: The tremendous range in the bulk of this product is demonstrated by graded samples, and the suitability of their manufacture for dentifrices, and similar pastes and powders, due to its extremely fine state of division, is shown by illuminated lantern slide micro-photographs.

Any particular grade of chalk required by a customer is obtained, not by mixing a lighter with a heavier, but is manufactured direct to the bulk required, thus ensuring a uniform and homogeneous product which can be exactly repeated in subsequent consignments.

Micro-photographs are also shown, demonstrating the harm which may be done to the teeth by the use of dentifrices containing unsuitable powders.

2.—*Products Obtained from the Grape*:

Sodium potassium tartrate or Rochelle salt, an ingredient of Seidlitz powder, and also used in the silvering of glass.

Potassium hydrogen tartrate, or cream of tartar, an ingredient of the oldest and most wholesome baking powder.

Neutral sodium tartrate.

Neutral potassium tartrate (6).

3.—*Products Obtained from the Lemon Fruit*:

Citric acid, in crystal, small crystal, granular or powder form.

Lemonade powder.

Sodium citrate.

Potassium citrate.

Iron ammonium citrate, red or green scales.

4.—*Other Products*:

Potassium bicarbonate, crystals or powder.

Pure potassium carbonate, hydrated and anhydrous.

Fluid magnesia, in small bottles ready for retail sale.

Lac magnesia.

All these chemical products are as free from the common impurities such as lead, arsenic, iron, copper and sulphate as it is possible to produce them. No material is allowed to leave the works without being subjected to rigorous chemical tests.

Thamar.

Specialising in original cosmetics—the most prominent of which are Thamar Sunburn Paste and Lotion Thamar. The first of these is very widely known, more especially in parts of the world where there is more sun than in Britain. A good deal is exported to Australia, New Zealand and S. Africa. Thamar hopes, through the Exhibition, to introduce it to the rest of the British Dominions and foreign countries.

Lotion Thamar is a very original skin-beautifier, in the preparation of which new-laid eggs play a prominent part. The particulars of this lotion, as also of other products, will be supplied at the stand.

The United Alkali Co., Ltd.

An exhibit making a special eature of the uses of the firm's various products in some of the main industries in this country, such as: Calico printing, dye manufacture, textiles, paper-making, glass-making.

The central stand will show pictures of these various industries, and below each picture will be an assortment of samples of the products used in each industry. A diagram of intermediates will also be shown.

The exhibit will also contain two upright columns encircled hy a series of panels rotating slowly. These panels will contain illustrations of the uses of the firm's products in various industries, such as: Soap-making, galvanising, tanning, agriculture, etc.

The Washington Chemical Co., Ltd.

This exhibit shows "Pattinsons" magnesia in its various forms, which has occupied for 80 years the premier position in the markets of the world, owing to its chemical purity, lightness, uniformity of colour, texture and freedom from hygroscopic moisture. It is manufactured solely by the

Washington Chemical Co., Ltd., whose works are situated within 8 miles of the city and port of Newcastle-on-Tyne.

The company was founded in 1840 by the late Mr. Hugh Lee Pattinson, F.R.S., the patentee of the process, in conjunction with the late Mr. R. S. Newall, F.R.S., and since that time the works have steadily increased in size to meet the growing demand for the company's various products. It is to-day the largest magnesia producing plant in Europe, the works property extending over an area of 50 acres.

Industrial.—The following varieties are manufactured by the company for industrial purposes: Light carbonate of magnesia in powder and in block; light calcined magnesia in powder and special heavy calcined magnesia in powder. As supplied to the following trades: Motor tyres, pneumatic and solid; electric cable insulation, the rubber industry in general, explosives, soap, printing ink, enamel ware, fine table salt, scientific glass, china glaze, cigarette papers, toilet powders, and many others in which its chemical purity and physical characteristics can always be relied upon.

Pharmaceutical.—"Pattinsons" magnesia has been known to the pharmaceutical trade throughout the world for the past 80 years, and is specially produced for this purpose to conform with the requirements of the British Pharmacopoeia. It is usually manufactured for druggists in the following varieties: Light carbonate of magnesia, ponderous carbonate of magnesia, light calcined magnesia, ponderous calcined magneisa, and fluid magnesia.

The powders and fluid are packed as above to suit the requirements of wholesale and retail druggists both at home and abroad. The company deal with orders for a few pounds packed in small bottles or tins for retailing directly to the consumer. With equal facility orders of many tons are regularly despatched to the large manufacturers of proprietary medicines and other medicinal preparations of which magnesia forms the active principle.

JOSEPH WATSON & SONS, LTD.

The firm is showing:—

Watson's Matchless Cleanser—a household word—for all domestic uses, both in respect to its cleansing properties, its laundry use, and personal use.

Nubolic Disinfectant Soap—a well-known disinfectant soap, used for all household purposes—also for personal use.

Venus toilet soaps; Venus shaving soaps; Sparkla polishing and scouring powder; Bumpo washing powder; Wolsil shredded soap—specially useful for washing woollens.

The exhibit also includes the products of the firm's seed crushing mills, which supply their requirements of technical cotton seed oils, soya oils, palm kernel oils, which are all used in the manufacture of their soaps. In addition they show the residuals, namely, feeding cakes.

J. & J. WHITE, LTD.

The firm are the oldest and largest manufacturers of chrome salts in the world. Their exhibit is designed to show the beautiful colours of the various chrome compounds, and to display some fine specimens of bichromate crystals. The contrast between the dull raw materials, namely, common salt, muriate of potash, chrome ore, limestone, and pyrites, and the brilliant finished products, is very marked.

The chief manufactures consist of bichromate of potash and bichromate of soda, both of which are largely used in dyeing, tanning, colour-making, etc. The potash salt crystallises in beautiful orange-red crystals, and is sold both in the crystalline and powder form. Bichromate of soda cannot be exposed to the air without absorbing moisture and therefore it is not possible to exhibit larpe crystals of this salt with the same freedom as in the case of the potash salt. The bichromate of soda is therefore shown only in the three forms in which it is put on the market—crystal, cake and anhydrous.

For some considerable time tanners have been using bichromates for tanning leather, having made from them chrome tanning liquors for this purpose. These liquors are often of very uncertain strength and the results obtained with them, therefore, vary. To avoid this the firm have produced a chrome tan liquor which can be crystallised and sold in the dry form. Both the liquor and the crystals have a basicity of 90, the liquor containing 12½ per cent. and the crystals 25 per cent. oxide of chromium.

(To be continued.)

CRITICAL STUDIES ON METHODS OF ANALYSIS.

XI.—SELENIUM.

By LEON A. CONGDON AND WILLIAM W. BRAY.

[*Contribution from the Department of Chemistry, Syracuse University.*]

INTRODUCTION.

Since the discovery of selenium by Berzelius in 1817, the study of this element so closely allied to tellurium and sulphur, has been mainly the formation of analogous compounds to sulphur, and also its separation from tellurium. Of the twenty-one studies found in the literature for its quantitative estimation, seven are gravimetric, twelve studies take up different phases of the volumetric process, one for a colorimetric method depending on the liberation of iodine by KI and H_2SeO_3, and one study on the applications of selenium to the industry with a suggestion to a quantitative method.

While selenium was in great demand during the world war, to replace manganese dioxide as a glass decoloriser due to the lack of ships for importation of manganese from Brazil, it is in further demand in normal times, due to the curious and peculiar properties of the element. This peculiar property is that selenium conducts electricity better when exposed to the light, hence it can be used in automatic devices for lighting buoys at night and for cutting off gas flow at daylight. This peculiar effect of light on the conductivity of selenium may give to selenium a greater importance, and its quantitative estimation is therefore of interest.

Gravimetric processes for the estimation of selenium fall into two classes, namely, the weighing the reduced element, or the dioxide of the element. The greater portion of gravimetric estimations reduce the solution of the sample containing selenium to the element and weighing as such. Among the reducing agents used are as follows: By $NaHSO_3$ in HCl solution; by hydrazine sulphate or hydrate in acid solution; by hypophosphorus acid in alkaline solution; by KI in HCl solution; and by SO_2 in 30 to 40 per cent. HCl solution. A gravimetric process for weighing the element as the dioxide has for its principle taking the basic nitrate dissolving in HCl, diluted with water, adding NH_4OH and acidifying with acetic acid, which precipitates the selenium as the dioxide, in which form it is filtered on a weighed Gooch crucible, dried and weighed as such. This last process, and also the SO_2 in 30 to 40 per cent. HCl solution process, will separate quantitatively the selenium from tellurium. The KI in HCl solution process will precipitate both selenium and tellurium in the solution. Volumetric processes for the estimation of selenium cover nearly all phases of the subject, namely, neutralisation, oxidation and reduction, and precipitation methods. The neutralisation method consists in first burning the sample in a tube with free oxygen in presence of Pt as catalyst, and then titration of the selenious acid formed with N/100 NaOH solution, the $NaHSeO_3$ being neutral to methyl orange. The oxidation methods use standard $KMnO_4$ in H_2SO_4 solution, and the excess $KMnO_4$ is titrated with standard oxalic acid. The reduction methods are mostly indirect iodometric processes, where the selenic acid is reduced to the selenious acid by KI, either in HCl solution or free chlorine into the KI, or by KBr and H_2SO_4. The evolved iodine is then measured with standard sodium thiosulphate, or reduction of the selenious acid to Se is brought about by standard $Na_2S_2O_3$ in HCl solution, and the excess of this reducing agent is determined by standard iodine. Another method is the separation of selenium from sulphur by burning in oxygen, then the SeO_2 is dissolved in KCN and the Se precipitated by HCl and SO_2, burned to SeO_2 and estimated iodometrically. Still another iodometric method boils the selenious preparation with H_2SO_4, then a known amount of KI is added, and an excess of arsenic acid. The reduction of selenious acid decreasing the reduction of arsenic acid, and then the quantity of arsenious acid at the close of the reaction is measured by standard iodine solution. A precipitation volumetric method noted was the boiling of the elementary selenium with ammonia and standard $AgNO_3$ solution, acidifying with HNO_3, determining the excess of $AgNO_3$ by standard ammonium sulphocyanide solution, using ferric alum as indicator. In this method, 4 of $AgNO_3$ is equivalent to 3 of Se.

The experimental work in this study takes up the following methods: Keller's (1) gravimetric reduction of SO_2 in HCl solution, the selenium weighed as the element; Bauer's (2) gravimetric reduction by $NaHSO_3$ in HCl

[we]ighed as the element; Marino's (3) volu[m]etric $KMnO_4$ method; and Gooch and [Pi]erce's (4) volumetric iodometric method.

EXPERIMENTAL.

The sample used in this study was the [bla]ck powdered variety of the element con[tai]ning an average percentage of 95.30 pure [sel]enium. No tellurium was present in the [sa]mple analysed. In Keller's gravimetric [me]thod and in Gooch and Pierce's volu[me]tric method, each sample was weighed [dir]ectly by means of a ground glass stop[per]ed weighing bottle, and then prepared [for] analysis. In Bauer's gravimetric method and Marino's volumetric $KMnO_4$ method, a known amount of the sample was weighed out by means of a ground glass stoppered weighing bottle, but this sample was dissolved in conc. HNO_3, evaporated to dryness, and the crystals of SeO_2 were again dissolved in conc. HNO_3 and evaporated to dryness. These last crystals of SeO_2 were then dissolved in distilled water and made up to 500 cc. in a calibrated measuring flask. Aliquot portions were then measured off by means of a pipette and then prepared for analysis of each determination.

The following table gives the results of this work:—

Method Used.	Wt. sample gram.	Amt. Se present %	Amt. Se obt. %	Aver. Amt. Se obt. %	Diff. from Se present %
Keller's	0.2161	95.30	95.05		
gravimetric	0.2138		93.83	94.44	-0.86
Bauer's	0.1044	95.30	95.21		
gravimetric	0.1044		94.06	94.94	-0.36
	0.1044				
Marino's Volu-	0.1032	95.30	95.33	95.37	-0.07
metric $KMnO_4$	0.1032		95.41		
(modified by authors)					
Gooch & Pierce's	0.1109	95.30	95.93	95.99	+0.69
volumetric	0.2736		96.05		
iodometric					

DISCUSSION OF RESULTS.

The method of procedure in Keller's gravimetric was to precipitate Se as such from a solution of selenious acid in strong HCl, the Se being precipitated while Te, if present, is not precipitated under such conditions. A sample of Se weighing about 0.2 grams was dissolved in conc. HNO_3, evaporated to dryness, and dissolved in HCl (Sp. gr. 1.175). SO_2 gas generated by the action of H_2SO_4 on Na_2SO_3, was passed through the solution to precipitate the Se, which was then filtered in a weighed Gooch crucible, washed, first with strong HCl, then with dilute acid. Then washed with water to remove the acid, and finally with alcohol, dried at 105°, and weighed as Se. The results obtained by this method were variable due probably to evaporation to dryness and boiling to change the light red precipitate to the denser, crystalline black form. Both of these procedures are liable to cause losses of Se through volatilisation. The average per cent. of Se obtained by this method was much lower than the amount of Se present in the sample.

In Bauer's gravimetric process, instead of using SO_2 gas, the precipitation of Se was effected by adding, to an aliquot of the solution of selenium, an excess of a solution of $NaHSO_3$. After this addition, the solution was boiled until the precipitate became black and heavy. The Se was then filtered off on a weighed Gooch crucible, washed as in the first method, dried at 105°, and weighed as the element. The results obtained exhibit variation, probably accountable for by sublimation or loss of some selenium during repeated evaporations and boiling. The average per cent. of Se obtained by this method was a little over 0.3 per cent. lower than the amount of Se present in the sample.

Marino's volumetric $KMnO_4$ method gives a method for the titration of selenious acid with an alkaline $KMnO_4$ solution used

as a basis. The straight method was tried first, but owing to the precipitation of MnO_2, which obscured the end point, this was discarded in favour of an acid solution. An approximately N/5 solution was made by dissolving 6 grams of $KMnO_4$ in water, filtering, and diluting to one litre. A N/5 solution of oxalic acid required about 12.6 grams in water, to which 36 grams of (1 to 3) H_2SO_4 had been added, diluted to a litre. Fifty cc. of selenious acid solution, prepared similarly as in the preceding method, were acidified with 10 cc. of H_2SO_4 (Sp. Gr. 1.2). Nitric acid was used with equally good results, but HCl reacts with the $KMnO_4$ in a way that the end point is lost. To the boiling solution of the selenious acid was added a very slight excess of standard $KMnO_4$. The resulting precipitate of MnO_2 was filtered off, oxalic acid standard solution added to remove the colour, and then the end point reached with a drop or two of the standard $KMnO_4$ solution. Although in acid solution, the $KMnO_4$ decomposes according to the equation:—

$$2KMnO_4 + 3SeO_2 = K_2O + 2MnO_2 + 3SeO_3.$$

The standardisation equivalents were found as follows:—

1 cc. oxalic acid = 1.092 cc. $KMnO_4$. $KMnO_4$ = 0.005867 gram per cc. = 0.0044 gram Se per cc.

Care must be taken in manipulation in this modified method. It seems necessary to add but one or two drops excess of $KMnO_4$ before filtering off the MnO_2 to get checks, hence the exact point at which to stop must be obtained by experience. If too much $KMnO_4$ is added and decomposed, the loss by filtering off the MnO_2 will be excessive.

In Marino's original process, where an alkaline solution is used, he uses the method on a sample of SeO, and by very careful work he found his method to give on an average of six determinations, -0.04 per cent. difference from the amount of selenium taken for analysis. The amount of SeO used as sample varied from 0.1403 gram to 0.3039 gram.

The method of Marino (modified by the authors) gave the most accurate method for Se tried in this study, and results were on the average much less than 0.1 per cent. with good checks.

The Gooch and Pierce volumetric iodometric method, by boiling a solution of selenious acid with H_2SO_4, a known amount of KI, and an excess of arsenious acid, it is found that the reduction of selenious acid decreases the reduction of arsenic acid, and the quantity of arsenious acid at the close of reaction is measured, after neutralisation by potassium bicarbonate, by standard iodine solution. This method gave results which were nearly 0.7 per cent. too high, but good checks were obtained.

The average accuracy of the above methods for selenium may be grouped in the following way, the most accurate coming first: Marino's volumetric $KMnO_4$ method (modified by the authors); Bauer's gravimetric reduction of $NaHSO_3$ in HCl solution and weighing the element; Gooch and Pierce's volumetric iodometric; and Keller's gravimetric reduction by SO_2 in HCl solution and weighing the element.

Summary and Conclusions.

1.—A critical survey of the methods for the estimation of selenium is given.

2.—Four methods for selenium estimation were investigated on a sample of the black variety containing 95.30 per cent. Se, and found to have the following accuracy, the most accurate coming first: Marino's volumetric $KMnO_4$ method (modified by the authors); Bauer's gravimetric reduction by $NaHSO_3$ in HCl solution and weighing the element; Gooch and Pierce's volumetric iodometric method; and Keller's gravimetric reduction by SO_2 in HCl solution and weighing the element.

3.—The most accurate method found in this investigation for the estimation of selenium is that of Marino, modified by the authors.

References.

(1) Keller, *Jour. Amer. Chem. Soc.*, 1897, XIX., 771.

(2) Bauer, *Ber.*, 1915, XLVIII., 507-8.

(3) Marino, L., *Zeit. Anorg. Chem.*, 1909, LXV., 32-37; Gooch, F. A., and Clemons, *Amer. Jour. Sci.* (3), L., 51.

(4) Gooch, F. A., and Pierce, *Amer. Jour. Sci.*, (4), I., 31.

PROCEEDINGS AND NOTICES OF SOCIETIES.

THE ROYAL INSTITUTION.

The After-Easter Session at the Royal Institution will commence on Tuesday, April 29, when PROF. BARCROFT begins a course of four lectures on *The Effect of Altitude on Man*. The Tyndall Lectures will be delivered this year by MAJOR M. S. TUCKER, Director of Sound Ranging in the Army, on *Acoustical Problems*. On Wednesday, April 30, and Thursday, May 8, MR. F. BALFOUR BROWNE will give two lectures on *Social Life among Insects;* on the succeeding Thursday afternoons, DR. E. V. APPLETON will deliver two lectures on *Atmospheric Interference on Wireless Telegraphy*, and DR. C. G. SELIGMAN two lectures on (1) *Divine Kings and Rainmakers of the Sudan*, and (2) *The Veddas of Ceylon*. On Saturday afternoons, beginning on May 3, there will be two lectures by DR. F. A. E. CROW, on *Heredity and Sex;* two by DR. W. G. ALCOCK on (i) *How Music is Made*, (ii) *Musical Ornamentation: its Origin and Development* (with musical illustrations), and two by MR. C. NABOKOFF on (i) *Shakespeare in Russia*, and (ii) *The Historical Triology of Alexis Tolstoi*. The Friday evening meetings will be resumed on May 2, when SIR ALEXANDER KENNEDY will deliver a discourse on *Petra*. Succeeding discourses will probably be given by Prof. V. F. K. Bjerknes, Dean Norris, Lord Rayleigh, and other gentlemen.

ROYAL MICROSCOPICAL SOCIETY.

The Section of the Society which has been formed to deal with the Industrial Applications of the Microscope, and to assist in the development of Industrial Research in British Industries, held a meeting on April 23. The Hon. Sir Charles Parsons, K.C.B., M.A., LL.D., D.Sc., F.R.S., presided.

Mr. J. E. Barnard, F.Inst.P., F.R.M.S., gave a fifth lecture demonstration on the methods of using a microscope and the elementary principle of observation and the interpretation of images.

Exhibits were shown by Messrs. J. W. Atha & Co. and Messrs. W. Watson & Sons, Ltd., and included a new form of laboratory polarimeter, dark ground illumination for colloids, etc.

Communications read:—

MISS ANNIE D. BETTS, B.Sc., *The Practical Use of the Microscope in the Beekeeping Industry.*

MR. SYDNEY R. WYCHERLEY, F.R.M.S., *Fibres, Analytical and Economic.*

THE PHYSICAL SOCIETY.

A meeting was held on April 11, when the following papers were read:—

On the Thermo-Electric Properties of Bismuth Alloys, with Special Reference to the Effect of Fusion. With a Note on Thermo-Electric Inversion, by C. R. DARLING, F.I.C., F.INST.P., and R. H. RINALDI, Finsbury Technical College. (The paper was accompanied by a demonstration.)

Preliminary Measurement of a Primary Gas-grown Skin, by J. J. MANLEY, M.A., Magdalen College, Oxford.

Removal of Gas-grown Skins from a Sprengel Pump, by J. J. MANLEY, M.A.

A Demonstration of Sub-harmonics produced by a tuning fork was given by W. N. BOND, M.Sc., University College, Reading.

Proceedings at the meeting on March 14, F. E. Smith, C.B.E., F.R.S., in the chair:—

A New Photo-Electric and Ionisation Effect, by U. A. OSCHWALD, B.Sc., and A. G. TARRANT, B.Sc.

For the discharge in a neon lamp to start a certain minimum voltage is necessary. This voltage is found to be affected very considerably by light or other ionising agents external to the lamp.

The authors have investigated the light effect. It is produced by illumination of any intensity above a very low value (0.01 foot-candles producing an appreciable effect), and is caused by rays of a broad wave-band in the visible spectrum, with a maximum effect in the orange. The seat of the effect is located on the surface of both the metal electrodes, irrespective of polarity.

A similar effect, but one whose mechan-

ism is believed to be different, is found to be caused by rays from uranium oxide and from an X-ray tube. In the latter case it was extremely well marked, so that it is possible to detect by this means X-rays from a very feeble tube at a distance of 90 feet.

Certain Properties of the Osglim Neon-Filled Lamp, by J. H. SHAXBY, B.Sc., and E. J. EVANS, B.Sc.

The characteristic (voltage and current) curve of the "Osglim" neon-filled lamp illustrates many of the properties of the discharge of electricity through rarefied gases. The identity of the sparking potential with that necessary to produce a minimal current through the gas, pointed out by Townsend, is clearly confirmed. Part of the characteristic is negative, and this results in the lamp discharge becoming intermittent on a direct current supply, over a certain range of external resistance, independently of any external condenser in the circuit.

This tendency to a negative characteristic appears whatever the current through the lamp, when any change is made in the circuit, and this produces instability at the moment of switching on the lamp, and in the case of A.C. supply causes an intermittent discharge during that part of the cycle, when, so far as the supplied volts are concerned, one would expect a continuous glow.

Notes on Some Electrical Properties of the Neon Lamp, by U. A. OSCHWALD, B.Sc., and A. G. TARRANT, B.Sc.

These notes consist of selected portions of a more comprehensive survey, and therefore deal with three isolated problems only, viz.:—

(1) The wave form of an "oscillating" neon lamp.

(2) The maximum frequency of an "oscillating" neon lamp.

(3) The persistence of the ionisation in a neon lamp.

The Critical Resistance for Flashing of the Low-Voltage Neon Discharge Tube, by J. TAYLOR, B.Sc., and W. CLARKSON, B.Sc.

The paper dealt with the resistance conditions necessary for the maintenance of the well-known phenomenon of "flashing" of the neon discharge tube.

THE GEOLOGICAL SOCIETY.

A meeting of the Society was held (April 9, when the following communic tions were read:—

The Roch, Trefgarn, and Sealyham V(canic Series (Pembrokeshire), by HERBE H. THOMAS, M.A., Sc.D., F.G.S., a A. H. COX, D.Sc., PH.D., F.G.S.

On an Olivine-Rhyolite from Eastern Ic land, by LEONARD HAWKES, M.Sc., F.G.

The President exhibited some fossils fro the Morte Slates (North Devon).

THE SOCIETY OF GLASS TECHNOLOGY.

THE DUPLICATION OF THE PORTLAND VAS

The President, Prof. W. E. S. Turn presided at the meeting of the Society Glass Technology, held in Stourbridge, Wednesday, March 19.

The first paper on the agenda dealt wi the *Properties of Lead-containing Glass* PROF. TURNER, who communicated th paper, described the special properties the alkali-lead oxide glasses, with partic lar reference to their thermal expansio chemical durability and electrical prope ties.

Mr. J. NORTHWOOD followed, with a pa entitled *The Art of British Glass Decorat —The Duplication of the Portland Va* The Portland Vase, he said, was regarded the greatest achievement of the ancie glass makers. Up to the time when Josi Wedgwood borrowed it from the Duke Portland for the purpose of imitating it his jasper ware, it was thought to be sto or earthenware, owing to its dull appe ance. The vase is composed of two glass the inner body or groundwork being of very dark blue transparent glass, and t outer casing of white opal glass out of whi the ornament and figures are sculptur This decoration stands up in relief from t blue ground.

The reproduction of the Portland V was accomplished by the late Mr. Jo Northwood, with the aid of his relative, M Philip Pargeter. The casing of the bl body with a uniform outer layer of opaq white was considered at that time as a m ter requiring great skill on the part of t glass maker. It was believed that t actual maker of the glass used in this En

lish Portland Vase was Daniel Hancock, of Wordsley.

Several blanks were selected, and one was found sufficiently good to be taken in hand in 1873, and carried through to completion. The exterior opaque white was slightly acidised by hydrofluoric acid, and the design drawn upon it. Then commenced the hard labour of removing the surplus white glass from round the figures and design, right down to the blue body ground. Extreme care and patience were necessary to chisel out, without mishap, the delicate details of the human form, in order to create a true reproduction. Hence, small carving tools were indispensable. As the work progressed through the three years of labour it entailed, Mr. Northwood was allowed by the authorities of the British Museum to take his work and place it beside the original for comparison. The vase was very nearly completed when it suddenly cracked, owing probably to a difference in co-efficients of expansion of the two glasses. Still, the artist was not discouraged, and in 1876 the work was completed. The vase, said Mr. Northwood, was now in the collection of Mr. P. Pargeter, of Stourbridge. It had been suggested that this work should come into national keeping.

THE INSTITUTION OF ELECTRICAL ENGINEERS.

The Faraday Medal of the Institution of Electrical Engineers will be presented to Dr. S. Z. de Ferranti, on Thursday, April 24, at 6 p.m., on which date Mr. G. Semenza, of Milan, will deliver the Fifteenth Kelvin Lecture, and will take as his subject, "Kelvin and the Economics of the Generation and Distribution of Electrical Energy."

FLUXES AND SLAGS IN METAL MELTING AND WORKING.

A general discussion on this subject is to be held on Monday, April 28, by the Faraday Society and the Institute of Metals, with the co-operation of the British Non-Ferrous Metals Research Association and the Institute of British Foundrymen. The meeting will be held from 3 p.m. to 7 p.m., with an interval for tea, at the Institution of Mechanical Engineers, Storey's Gate, S.W.1. A general introduction will be given by Professor C. H. Desch, and there is a programme of some fourteen papers intended to initiate discussion on the various aspects of the subject. The papers deal primarily with the uses of fluxes and slags in the smelting and refining of the non-ferrous metals, but there will be one section dealing with fluxing problems in arc and oxy-acetylene welding. The subject of slag inclusions will also be dealt with.

A copy of the complete programme may be obtained from the Secretary of the Faraday Society, 10, Essex Street, London, W.C.2.

NOTICES OF BOOKS.

Icarus, or The Future of Science, by BERTRAND RUSSELL, F.R.S. Pp. 64. London: Messrs. Kegan Paul, Trench, Trubner & Co., Ltd., Broadway House, 68-74, Carter Lane, E.C. 1924. 2s. 6d. net.

In a bold forecast, the author indicates the sinister influence that scientific discovery may have, if it should fall into the power of unscrupulous minds. It is pointed out that men's collective passions are frequently evil. The strongest are hatred and rivalry directed towards others. By manipulating the Press, and influencing public knowledge by suppressing or spreading information, true or false, the author urges that it is conceivable for a group of men to attain excessive power.

Then, with the aid of the instruments of science, they could proceed to mould the rest of the human race into such beings as are portrayed by Čapek in *Rossum's Universal Robots*.

Men of science may be urged to refrain from making further investigations and discoveries for fear that these may be used in undesirable ways. (Mr. Russell does not suggest this, however.) But it is unpractical and impossible to arrest the pursuit of scientific knowledge, even if this be desirable on certain grounds. If knowledge is made to serve wrong purposes, the fault does not lie with the scientists.

Mr. Bertrand Russell has written a valuable and thoughtful book, which should be read in conjunction with Haldane's *Daedalus*.

J.G.F.D.

The Broadcast Listeners' Year Book, 1924. Pp. III. + 79. London: Radio Press, Ltd., Publishers of Authoritative Wireless Literature, Devereux Court, Strand. Price 1s. 6d.

The development of wireless and the popularity it has attained recently has created the need for such a guide as the one under review.

The book explains in non-technical language many matters of interest to listeners of broadcasting. In addition, there are chapters on the future of wireless, and Continental broadcasting.

Messrs. Rayner & Co. have just issued a booklet, entitled, *Unbranded,* which will be sent to any address on request. The object is to draw attention to the importance of registered trade marks, which safeguard the manufacturer. In view of the Empire Exhibition this subject is of special interest to industrialists.

The *Photographic Journal* for April contains, amongst scientific papers: "The Measurement of Photographic Density," by H. M. Cartwright and A. J. Bull; "The Characteristic Properties of some Kinematograph Film Stock," by O. Block; and "A New Density Meter," by F. C. Toy and S. O. Rawling.

On Thursday, April 10th, at 6.30 p.m., the annual meeting was held of the Scientific and Technical Group of the Royal Photographic Society, followed at 7 p.m. by a paper on "The Washing of Photographic Products," Parts III. and IV., by K. C. D. Hickman and D. A. Spencer.

BOOKS RECEIVED.

Chemical Encyclopædia — A Digest of Chemistry and Chemical Industry, by C. T. Kingzett, F.I.C., F.C.S. Pp. VIII. + 606. Third Edition, 1924. Messrs. Bailliere Tindall & Co., 8, Henrietta Street, Covent Garden, W.C.2. 30s. net.

Boric Oxide as a Constituent of Glass, Arranged and Compiled by H. Goulding-Brown. Pp. 47. 1924. Borax Consolidated, Ltd., 16, Eastcheap, E.C.3.

PUBLICATIONS RECEIVED.

Weeds of South Africa, Part II., by K. A. Lansdell. Pp. 38. 1923. The Govt. Printing Office, Pretoria. 3d.

Experiments on the Distillation of Zinc from Zinc-Lead-Silver Ores, by B. M. O'Hara and E. S. Wheeler. Issued as a bulletin of the School of Mines and Metallurgy, University of Missouri.

BULLETINS ISSUED BY THE U.S. DEPARTMENT OF THE INTERIOR, BUREAU OF MINES.

Carbon Monoxide Hazards from House Heaters burning Natural Gas, by C. W. Jones and W. F. Holbrook. Pp. IV. + 31.

Methods for the recovery of Platinum, Iridium, Palladium, Gold and Silver from Jewellers' Waste, by C. W. Davis. Pp. 111 to 114.

Wall Plaster—Its Ingredients, Preparation and Properties. Pp. 66.

New Patents.

This list is specially compiled for *The Chemical News* by Messrs. Rayner & Co., Registered Patent Agents, of 5, Chancery Lane, London, from whom all information relating to Patents, Trade Marks, and Designs can be obtained gratuitously.

Latest Patent Applications.

8375—Fabrique de Soie Artificielle de Tubize Soc. Anon.—Production of concentrated acetic acid from aqueous solutions thereof. April 2.

8271—Steffen, C.—Continuous deposition of tricalcium saccharate. April 1.

Specifications Published this Week.

190114—Poma, G. (deceased), and Pellegrini, G.—Process for the manufacture of acid H (amino-naphthol-disulphonic 1, 8, 3, 6).

212970—Shannan, W. V., Siderfin, N. E., Adam, W. G., and Gas Light & Coke Co.—Manufacture of organic compounds by reactions involving replacement of substituent atoms or groups with liquid reagents.

212990—Petroff, G.—Process of separating oxidised fatty acids from non-oxidised fatty acids.

213088—Cruse, H.—Manufacture of acetate of alumina by electrolysis.

Abstract Published this Week.

211322—Manures: white lead.—Marris, H. C., and Walker & Sons, Ltd., W., Rose Hill Tannery, Bolton.

Spent tan, spent dye-woods, brewers' refuse, sawdust, cork-dust, straw, chaff or like inert vegetable matter are mixed with inorganic substances which, together with the vegetable matter, will support bacterial life, and the mixture is placed in a pit, enclosed space or heap so that air is excluded and anaerobic bacteria will develop. The added substances may contain nitrogen, potassium, and phosphorus, which may be in the form of ammonium sulphate, potassium sulphate, and basic slag. The product may be used as manure, and spent tan so treated may be used in the "stack" process for the manufacture of white lead. *When the product is used to form a hot-bed,* a portion of the phosphorus may be added as a solution of sodium orthophosphate which is poured over the hot-bed at intervals.

Messrs. Rayner & Co. will obtain printed copies of the published specifications and abstract only, and forward on post free for the price of 1s. 6d. each.

THE CHEMICAL NEWS,

VOL. CXXVIII. No. 3342.

A NEW VOLUMETRIC METHOD FOR THE ESTIMATION OF TIN.

By J. G. F. Druce, M.Sc. (Lond.), R.Nat.Dr. (Prague).

Knop (*J. Amer. Chem. Soc.*, 1924, XLVI., 263) has described a new method for the titration of solutions of ferrous iron with potassium dichromate, using diphenylamine as the indicator.

It is stated that in the presence of ferric salts, diphenylamine sulphate is oxidised by potassium dichromate with the formation of an intense blue colour. Addition of a ferrous salt decolorises the solution again.

Knop incidentally mentions that the method can be used for the titration of ferrous solutions obtained by reduction of ferric salts with stannous chloride, and he includes some results of titrations of solutions obtained on the reduction of ferric oxide by stannous chloride.

The present communication deals with an examination of the method for the purpose of estimating tin.

In one set of experiments the stannous solution was treated with excess of a ferric solution (iron, alum or ferric chloride), and the ferrous salt formed was titrated with the decinormal potassium dichromate solution. A drop of a solution of diphenylamine in concentrated sulphuric acid constituted the indicator. This solution was made, in accordance with Knop's directions, by dissolving 1 gr. of diphenylamine in 100 cc. of concentrated sulphuric acid.

In order to sharpen the end-point when large volumes of dichromate were required, a special sulphuric-phosphoric acid solution was added. This was made by mixing 150 cc. of sulphuric acid (d. 1.84) with 150 cc. of phosphoric acid (d. 1.70), and then making the volume up to 1 litre with water. Fifteen cc. of this were introduced into each titration.

The method has been compared with other volumetric processes for the estimation of tin (see *The Chemical News*, 1920, CXXI., 173). Except for the initial trouble in preparing the solutions, it appeared quite satisfactory.

The following table gives the results of typical titrations when 20 cc. of approximately decinormal (by weighing) stannous chloride were used:—

	Knop's Method. cc. $K_2Cr_2O_7$ required.	Reynold's* Method. cc. $K_2Cr_2O_7$ required.	Iodine Method. cc. I_2(N/10) required.
	19.70	19.60	19.50
	19.90	19.45	19.20
	19.90	19.55	19.35
	19.75	19.40	19.30
Average	19.81	19.50	19.44

* See below.

It will be noticed that the results are slightly higher for the new method. In a blank experiment one drop of a fiftieth normal dichromate was sufficient to produce the blue colour, which was immediately destroyed by a drop of the stannous chloride solution.

Contrary to the statement of Knop, that no colouration is produced by the dichromate in the absence of iron salts, it has been found possible to titrate stannous solutions with potassium dichromate directly, *i.e.*, without the addition of ferric salts.

Using 20 cc. of the same stannous chloride solution the following quantities of decinormal dichromate were required:—

Expt.	cc. $K_2Cr_2O_7$
1	20.05
2	19.90
3	19.95
4	19.90
Average	19.95

The use of diphenylamine (as sulphate) as indicator recalls the one first described by Reynolds (*The Chemical News*, 1908, XCVII., 13; see also Druce, *loc. cit.*), obtained by heating azobenzene with concentrated sulphuric acid.

Knop suggests that the oxidation of the diphenylamine sulphate can be explained on the basis of the work of Kehrmann and Micewicz (*Ber.*, 1912, XLV., 2641).

From a study of the reaction of oxidising agents on diphenylamine these authors concluded that the blue colouration is due to the formation of quinoneimonium salts of the composition

$$N.Ph:C_6H_4.C_6H_4:N.Ph,HX,$$

produced by the oxidation of the NN'. diphenylbenzidine formed by the action of the sulphuric acid on diphenylamine.

CRITICAL STUDIES ON METHODS OF ANALYSIS.

VIII.—Barium.

By Leon A. Congdon and Dorothy Fitzgerald.

[*Contribution from the Department of Chemistry, Syracuse University.*]

Introduction.

The estimation of barium as the chromate gravimetrically has been the subject for investigation from about 1870, since it has been recognised that this compound is quite *insoluble in water at ordinary temperature*. The literature shows about 31 references for the quantitative estimation—21 of which refer to the gravimetric determination or separation from interfering substances, and most of these gravimetric methods refer to the estimation of barium as the chromate. There was encountered seven volumetric processes, two processes for indirect gasometric analysis, and one reference to the influence of barium or calcium and magnesium precipitates by spectroscopic detection.

This study comprises the comparison of eleven methods for the estimation of barium—seven gravimetric processes and four volumetric ones. The gravimetric method examined were (1) barium as the oxalate in presence of alcohol; (2) barium as the sulphate by evaporation; (3) barium as the chromate; (4) barium as the sulphate by precipitation; (5) barium as the carbonate (6) barium estimated by precipitation of the chloride as AgCl; and (7) barium as the bromide.

The volumetric methods were (8) Ruoss's neutralisation method; (9) Sutton's precipitation process as the chromate; (10 Peters' oxalate-permanganate method; (11 Solstein's precipitation process as the chromate using logwood extract or haematoxylin as indicator.

Experimental.

The sample used in this work was $BaCl_2.2H_2O$, showing a trace of sodium, CaO 0.01 per cent., Fe 0.003 per cent., and no SrO, $BaClO_4$ or HNO_3 present. The sample was prepared for most of the work by taking 16.1420 gr. of this salt dissolved in water and made up to 1 litre. Twenty-five cc. portions were aliquoted and used for each determination, giving a sample of 0.4036 gr. In the case of two determinations, 0.4104 gr. of sample was used.

The following table shows the results of the work:—

Method Used.	Amt. sample grams.	Theor. P.c. Ba.	Amt. Ba obtained p.c.	Avge. Amt. Ba obt'd p.c.	Diff. from Theor. p.c.
As oxalate gravimetric (author's mod. calculation)	0.4104	56.21	55.95	55.95	-0.26
As sulphate by evaporation gravimetric	0.4036	56.21	56.10 56.73	56.41	+0.20
As chromate gravimetric	0.4036	56.21	56.60 56.56	56.53	+0.32
As sulphate by precipitation gravimetric	0.4104	56.21	56.61 56.40	56.50	+0.29
As carbonate gravimetric	0.4036	56.21	56.10 56.02	56.06	-0.15
Authors' method by ppt'n of chlorine of $BaCl_2$ as AgCl gravimetric	0.4036	56.21	56.43 56.17	56.30	+0.09
Ruoss's vol. neutralisation	0.4036	56.21	53.32 53.96	53.64	-2.57
			54.49	54.35	-1.86

No results could be obtained by Thorne's ·avimetric precipitation method by forma- on of $BaBr_2$ by HBr in ether, since *aBr_2 was too soluble, and only a slight* oudiness could be seen and practically no ·ecipitation obtained, even on long stand- g.

We did not obtain any results on P. Sol- ein's volumetric method by $K_2Cr_2O_7$, us- g either logwood or haematoxylin as an dicator, since no accurate end-point could : obtained.

Further negative results were experi- iced with Peters' volumetric estimation of ırium as oxalate on account of difficulty washing out the excess of $(NH_4)_2 C_2O_4$, hich crystallised from the alcoholic solu- on and became completely mixed with the aC_2O_4. The precipitate cannot be washed ith water because BaC_2O_4 is soluble in ater. Hence in this volumetric estimation e excess of oxalate used could not be curately titrated with standard $KMnO_4$ ·lution.

PRINCIPLES AND DIFFICULTIES OF SUCCESSFUL METHODS.

Gravimetric Oxalate Method. — This ethod was at first followed as given by ooch, wherein the BaC_2O_4 is precipitated an excess of $(NH_4)_2 C_2O_4$ solution in a t solution of the neutral salt with one- ird its volume of alcohol (85 per cent.), ıd allowed to stand over night. The pre- pitate was then filtered off on a tarred ooch crucible, washed with 95 per cent. cohol and heated at 100° C. to constant eight. Results were found nearly 2 per nt. too high if the weights were taken as aC_2O_4. The authors find that if the eights are taken as $BaC_2O_4.\frac{1}{2}H_2O$ under e conditions stated, the theoretical per nt. of barium was nearly slightly less an the general experimental error of 0.2 r cent. Hence the authors modify this ethod by using the corrected product tained, since good checks were obtained duplicate.

Since the completion of this work Ange- scu (1) washes the precipitate with 75 per nt. alcohol, dries the oxalate for about o hours at 70° C., and weighs as $C_2O_4 H_2O$, but has to allow 2 mg. for lubility of precipitate. He makes no ention as to change of water constitution ntent by effect of different amounts of at.

Gravimetric Chromate Method.—A. Bau- n's procedure was modified in this study, where the $BaCrO_4$ was precipitated from a solution of the salt by the addition of ammonium acetate, and a solution of K_2CrO_4 was then added in excess. Bauman used $(NH_4)_2CrO_4$ instead of K_2CrO_4. The precipitate was washed with weak K_2CrO_4 solution and very weak NH_4OH, and was collected on a tarred filter and dried at 100° to 120° C. The results obtained were slightly higher than the average experimental error of 0.2 per cent.

Gravimetric Sulphate Precipitation Method.—This method has been studied by a considerable number of investigators, where sulphuric acid is to be determined by means of a solution of $BaCl_2$. The method for barium used in this study is that given by Fresenius, where the solution of the neutral salt of barium is heated to boiling and H_2SO_4 added until no further precipitate forms. The precipitate is boiled once with the H_2SO_4, then four times with water, and finally filtered, washed free from sulphate, and ignited to constant weight. The results obtained were slightly higher than the theoretical per cent. of barium in the sample.

Gravimetric Carbonate Method. — Fresenius' procedure was followed, where the $BaCO_3$ is precipitated from an alkaline solution of the salt by adding ammonium carbonate solution in slight excess, and then letting stand several hours in a warm place. The precipitate is then filtered, washed with dilute NH_4OH, dried, and finally ignited in Bunsen flame as $BaCO_3$. Fresenius states an accuracy within 0.12 per cent., while our results show the method to give lower results than theoretical within 0.15 per cent.; although good checks were obtained in duplicate.

Gravimetric Chloride Method.—This procedure is, of course, only applicable when the barium exists as the chloride, and serves as an excellent check on the theoretical combination of the barium. It is an indirect method and the procedure followed was to acidify the $BaCl_2$ solution with 5 to 10 cc. HNO_3, heat to boiling and add $AgNO_3$ solution until the precipitation was complete—shown by the coagulation of the AgCl and clearness of the supernatant liquid. This requires vigorous stirring and heating. The AgCl precipitate is filtered on a tarred Gooch filter and heated at 100° to 110° C. to constant weight. From the AgCl, the corresponding barium can be calcu-

lated. This indirect method was the most accurate method tried by the authors.

Volumetric Neutralisation Method.—This is Ruoss's process for a solution of a barium salt. An excess of Na_2CO_3 is added to a solution of the salt, phenolphthalein added as indicator, the solution boiled and cooled, and a standard HCl solution added drop by drop. The red colour disappears when half the excess of Na_2CO_3 has been neutralised. This method gives very poor results, and results were over 2 per cent. lower than theoretical.

Volumetric Chromate Precipitation Process.—This method was followed as given by Sutton, where a standard solution of $K_2Cr_2O_7$ (1 cc. = 0.0051 gm. $K_2Cr_2O_7$) is carefully added to the solution of a barium salt with agitation as long as any precipitate is formed and until the clear supernatant liquid has a slight yellow tint. The authors found that the precipitate of $BaCrO_4$ will not settle, and even after standing for several hours the supernatant liquid was not clear. This, of course, prevented an accurate determination of the end-point. The authors therefore added an excess of $K_2Cr_2O_7$ standard solution, filtered off the precipitate, and titrated for the excess with standard $FeSO_4$ solution. The results were nearly 2 per cent. lower than the theoretical per cent. of barium in the samples analysed. The method cannot therefore be considered a very accurate one.

SUMMARY AND CONCLUSIONS.

1.—Eleven methods were studied for the estimation of barium in a sample of $BaCl_2.2H_2O$ of known purity.

2.—Three methods were found to be worthless, namely: Thorne's gravimetric estimation of barium as the bromide; Peters' volumetric estimation of barium by oxalate—$KMnO_4$ method; and Solstein's volumetric precipitation process as the chromate, using either logwood extract or haemotoxylin as indicator.

3.—Two methods, *i.e.*, Ruoss's volumetric neutralisation process and Sutton's volumetric chromate precipitation process, were found to give approximately 2 per cent. lower results than theoretical.

4.—The following gravimetric methods gave results within or approximately within 0.2 per cent. of the theoretical per cent. of barium, and can be listed as to their accuracy as follows, the most accurate coming first: Indirect method by precipitation of chlorine of $BaCl_2$ as AgCl (suggested b authors); barium gravimetrically as tl carbonate; barium gravimetrically l evaporation as the sulphate; barium grav metrically as the oxalate (modified by tl authors); barium precipitated as the su phate; and barium gravimetrically as tl chromate.

References.

(1) See Gooch, "Methods in Chemic Analysis," 1912, 160; modified by tl authors; Angelescu, B. N., *Bull. So Chim. Roumania*, 1923, V., 12-15.

(2) See Fresenius, "Quantitative Anal sis," 229.

(3) Fleischer, E., *Zeit. Anal. Chem* 1870, IX., 97; Kammerer, H., *Zeit. Ana Chem.*, 1873, XII., 375; Frerichs, F., *Ber* 1874, VII., 800, 956; Meschezerski, J *Zeit. Anal. Chem.*, 1882, XXI., 399; Fres nius, R., *Zeit. Anal. Chem.*, 1890, XXIX 20, 143, 413; *Ibid.*, 1891, XXX., 18, 45 583; *Ibid.*, 1893, XXXII., 183, 312; Ba man, A., *Zeit. Anorg. Chem.*, 1891, 20 Baubigny, H., *Bull. Soc. Chim.*, 1895 (3 XIII., 326; *Ibid*, 1907 (4), 1., 55.; Robi H., *An. Chim. Anal.*, 1903, XVIII., 445 Carou, A., and Ragnet, M., *Bull. So Chim.*, 1906 (3), XXXV., 1061; Kahan, B *Analyst*, 1908, XXXIII., 12; Vander Ho and Vander Bos, *Chem. Weekblad*, 191 VIII., 5; *Ibid.*, 1912, IX., 1002.

(4) See Fresenius, "Quantitative Analy sis," 229; Hill and McQuick, *Jour. Ame Chem. Soc. Abstr.*, 1909.

(5) See Fresenius, "Quantitative Anal sis," 229.

(6) Authors' method.

(7) Thorne, N. C., *Ann. Chem. Anal.* 1904, XXX.; *J.C.S.*, 1904, LXXXVIII. 118.

(8) Dr. Ruoss, *Journ. Chem. Soc. Abstr.* 1896, II., 500.

(9) Sutton, F., "Volumetric Analysis," 1911, 165.

(10) Peters, Chas., *Journ. Amer. Chem Soc.*, 1901; *Journ. Chem. Soc. Abstr.* 1901, LXXX., ii., 692.

(11) Solstein P. *Pharm. Zeit.* 1901 XXXV., 372

AN EXPLANATION OF THE THEORY OF THE ROTATION OF THE ATOMIC NUCLEUS.

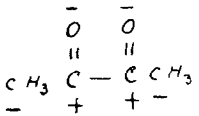
PART VI.

By HERBERT HENSTOCK.

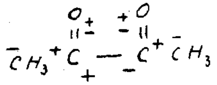
(*Concluded from Page* 260.)

The above is a good illustration of the necessity of correctly labelling the *bonds*, and not the atoms, for if + and - signs be placed indiscriminately, making all the atoms of a chain wholly positive or wholly negative, it must lead to confusion.

Another case of this kind is that of the di-ketones, which, written

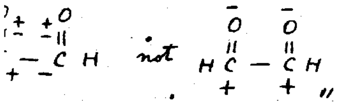


yield the anomaly of two positive atoms linked together, whereas

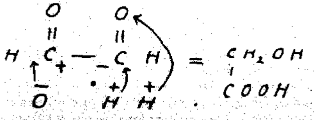


correctly expresses the polarities of the bonds, and shows that the bond between the two central carbon atoms is weak.

Similarly, the di-aldehyde, glyoxal, should be:



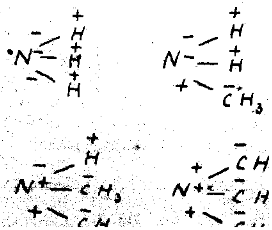
on treating this with alkali one CHO group is affected in a different way from the other: as



one is oxidised the other reduced, the difference in polarity of the bond between the carbon atoms partly accounting for the reaction. The oxidation of benzil to benzilic acid is another example applied to a di-ketone.

In compounds where such a permanently polar negative atom as oxygen is united to carbon by either a single or a double bond, the strength of the pull of the oxygen nucleus upon the negative edges of union of its octet is greater than that of the carbon nucleus on the positive edges of its octet, and in consequence the carbon electrons, joining in the union, are held rather more tightly to the oxygen than to the carbon: this slightly increases the permanent negative polarity of the oxygen as well as the permanent positive polarity of the carbon, constituting it a positive atom in the usually accepted sense of induced alternate polarity; it will therefore tend to unite with other atoms or groups along its positive edges, as though it had no negative edges; but this is only a tendency, and need not occur in every case, as is seen from the above examples; the more negative the atom or group uniting with the carbon, the more will the above tendency operate, and with two or three such groups already attached, the remaining bonds of the carbon will tend more and more in the same direction, but should the carbon link up by a positive bond, then that bond will usually be weak, the weakness increasing with the number of negative groups bound to the atom. The reverse of this for positive atoms or groups united to carbon also holds, and the whole applies equally to other elements, which differ in permanent polarity, *e.g.*, nitrogen and carbon, sulphur and carbon, oxygen and nitrogen, etc. If the above explanation be borne in mind, many of the difficulties in applying the theory of alternate polarities will be smoothed away, and at the same time it will prevent misunderstanding of the author's interpretation of how that theory works.

A good illustration of the above is afforded by the amines:



The nitrogen in ammonia is completely negative, but as each methyl group attaches itself to a positive edge, and not to the negative one vacated by the hydrogen, the nitrogen becomes more and more positive, each *alternate* polar union strengthening its *permanent* polarity, thus permitting the whole molecules to act as bases. Without some explanation of the kind here offered, it is impossible to distinguish between the polarity of the nitrogen in methylamine and that in trimethylamine, or to demonstrate why one is a stronger base than the other.

The amines are also an example of the loosening of hydrogen by a negative atom or group, mentioned by Kermack and Robinson (*loc. cit.*), who illustrate the action of bromine. Either bromine or the CH_3 group will unite with carbon along one of its positive edges, displacing hydrogen united to a negative edge: the remaining hydrogen atoms of the ammonia are then not so strongly held as before. This may be also very well seen in the series, CH_4, CH_3Cl, CH_2Cl_2, $CHCl_3$, CCl_4. From left to right the hydrogen is less strongly held to the carbon, and from right to left the chlorine is less strongly held. As more of the positive edges are occupied by chlorine, which holds the carbon electrons tightly, the carbon becomes more positive, and so more inclined for union along positive edges, thus the negative edges, to which the remaining hydrogen is attached, become weaker, so that this loosening effect is not only operative at the moment of reaction, but may be permanent, although it is probably more pronounced at the reaction moment.

An interesting case, demonstrating the universal applicability of nuclear rotation, is the isomerism of the oximes, which are shown in general by Fig. 3.

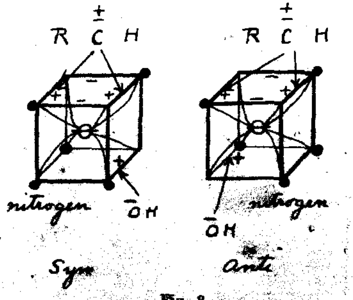


Fig. 3.

Revolution of the nucleus would not convert the one into the other; each atom would have to be turned through an angle of 180°. There is only one free positive covalence bond in each nitrogen atom, for union with the OH group.

Chemical Research Laboratory,
School Gardens,
Shrewsbury.

STUDIES IN THE REACTIONS OF THE AMINO GROUP IN 4′ AMINO 1 PHENYL 5 METHYLBENZOTHIAZOLE.

Part 8.—Azo Dyes Derived from 4′ Amino 1 Phenyl 5 Methylbenzothiazole, and a Modified Preparation of Dehydrothioparatoluidine.

By R. F. Hunter, F.C.S.

It is well known that the thiazole dyestuffs are essentially derivatives of dehydrothioparatoluidine and its higher homologue primuline. Both primuline and dehydrothioparatoluidine are primary amines, which are readily diazotized and coupled in the usual manner to yield azo dyestuffs, many of which are of considerable commercial importance (see Part 1 of this series of papers).

In the same way as the odour of these benzothiazoles, which have been discussed in this series of papers, depend on the reactions of the six-membered homocyclic five-membered sulphur nitrogen heterocyclic fused ring system of benzothiazole, so clearly do the properties of the thiazole dyestuffs depend on this system.

The experiments discussed in this paper were undertaken firstly with a view as to obtaining further information as regards the reactivity and reactions of the amino group in dehydrothioparatoluidine, and secondly with a view to examining the function of the thiazole ring as a chromophore. In some preliminary experiments, carried out a year or so ago, 4′ diazonium 1 phenyl 5 methylbenzothiazole was found to couple readily with resorcinol, the naphthols and salicyclic acid to give good yields of azo dyestuffs. The preliminary experiments were, of course, only carried out on a small scale, and it was therefore decided to repeat this work, using larger quantities of the materials, and further to examine the properties of the azo dyestuffs.

When dehydrothioparatoluidine is diazo-

tized, there is a strong tendency for the formation of the diazoamino compound to take place, and therefore the diazotizing in these cases described hereunder was carried out in strongly acid solutions, and the coupling was carried out in acid solution as described hereunder. This, of course, represents a departure from the usual procedure of coupling phenolic substances in alkaline solutions. The azo substances prepared in this way appear to be insoluble in the commoner solvents and in dilute, and even fairly strong acid solutions. This made it impossible to ascertain the fastness of the dyes, and hence it has been decided to reprepare these dyestuffs in the normal way, that is to say, coupling in an alkaline bath, at an early date.

The insolubility appears strange, but in some recent experiments (*loc. cit.*) it has been shown by the author that many of this series of benzothiazoles, though insoluble in boiling solvents even after ten minutes' boiling, on being refluxed for several hours, dissolve, and on cooling yield crystals of the thiazole in the ordinary way. This has been noted particularly in the case of dehydrothiotoluidine dibromide. This is readily prepared by brominating an alcoholic solution of dehydrothioparatoluidine in alcohol, when the addition product separates out as a dark brown solid, insoluble in boiling alcohol which, on analysis for halogen, gives the correct figures for bromine. If the bromthiazole, however, is refluxed with alcohol for several hours on a boiling water bath, solution takes place with the deposition of brown crystals, which, on cooling, yield, on analysis, practically the same figures for halogen as the original substance, and which are, if anything, a cleaner and purer product than the uncrystallised material. The same phenomenon has been observed by the author in the case of the product of arsenical fusion of dehydrothioparatoluidine. It would thus appear that these thiazoles can exist in isomeric modifications, one form being readily soluble and the other quite insoluble but transformed into the soluble modification after several hours' refluxing.

The dehydrothiotoluidine used in this set of experiments was the ordinary commercial intermediate obtained from the British Dyestuffs, Ltd. It contains a certain amount of primuline which, however, does not interfere in any way with the preparation of the azo dye. Nevertheless, in the subsequent preparations, it has been decided to free the material completely from the higher homologue. This procedure is quite simple, owing to the insolubility of primuline in ethyl alcohol, and a method of separation is given in this paper. The material, as prepared in this way, melts below the correct melting point of the thiazole, but is quite pure for ordinary experiments. To obtain the compound of the correct melting point (190°) it is necessary to recrystallise continually until the correct M.P. is obtained. Each crystallisation, however, involves a considerable loss of material, and also it is often very difficult to induce crystallisation in the benzothiazoles, particularly in dehydrothiotoluidine and its derivatives, owing to the extraordinary tendency which these compounds have to "tar up" into a brown viscous mass and sometimes into a hard black solid. These difficulties have already been discussed by the author (*J.S.C.I.*, 1923, XLII., 302). In any case, the pale yellow crystals from ethyl alcohol, which melt two or three degrees below the melting point given in the literature, are quite pure in the ordinary sense of the word. As regards the melting point of dehydrothiotoluidine, the literature is somewhat contradictory. Thus Belstein gives the melting point as 190°, other workers in the field have recorded it as 191°, 192°, and lately Meyer (*The Chemical News*, 1922), has recorded a sample of the thiazole obtained by distillation and subsequent crystallisation from ethyl alcohol which melts at 194° C. He further reports a dark tarry form obtained by crystallisation from cold acetone which melts at 225° or above this (*loc. cit.*). The author has observed, when dealing with samples obtained when the temperature of sulphur fusion of paratoluidine was allowed to rise much above 220° C., that melting points considerably above 200° C. can be obtained. The peculiar point is that these substances all behave more or less the same in their reactions. Thus, even from the black solid sometimes obtained in purifying from alcohol, the normal nitro derivative of dehydrothioparatoluidine can be obtained by normal nitration with concentrated nitric acid, etc.

However, for preparation work, the method described hereunder, modified from that previously described by the author (*Trans. Soc. Chem. Ind.*, 1923) is recommended.

As regards the azo dyestuffs, the three

derived from resorcinol and the naphthols are a splendid red in colour. The azo compound obtained from salicyclic acid is an orange brown colour, and is assumed to be (4), the others to have the constitutions (1), (2), and (3).

$$CH_3C_6H_3 < {}^{S}_{N} > C\ C_6H_4N_2C_6H_3(OH)_2.$$

(1)

$$CH_3C_6H_3 < {}^{S}_{N} \geq C\ C_6H_4N_2C_{10}H_6OH.$$

(2 and 3)

$$CH_3C_6H_3 < {}^{S}_{N} \geq C\ C_6H_4N_2C_6H_3(OH)CO_2H$$

(4)

The dye from beta naphthol has been previously described by Morgan, who purified it from glacial acetic acid, and described its properties, etc. (*J.C.S.*, 1922, CIXX., 1070).

Experimental.

4′ Amino 1 Phenyl 5 Methylbenzothiazole:

100 gms. of *p*-toluidine are mixed with 50 gms. of powdered sulphur and heated at 220° C. for four to five hours, as described (*J.S.C.I.*, 1923, XLII., 302). The product is worked up by the method described by the author in the above paper. The alcoholic extract is concentrated and drowned in cold water, when a pale yellow precipitate forms. This is filtered, and dried and crystallised from ethyl alcohol. The yield is higher owing to the precipitation as a preliminary purification, and the melting point is below 190° C.

1 Phenyl 5 Methyl Benzothiazole 4′ Azo Resorcinol:

5 gms. of dehydrothiotoluidine, in the form of a fine powder, are weighed into a 350 cc. beaker, and 80 ccs. of concentrated hydrochloric acid are added, and the contents of the beaker stirred till a fine suspension of the hydrochloride of the base is formed. Considerable heat is produced during the conversion. The solution is then diluted somewhat by the addition of small lumps of ice and some 100 ccs. of ice-water. The solution is stirred till the ice melts, ar the beaker is placed in a freezing mixture ice and salt. The solution is cooled to 0° C when the theoretical sodium nitrite in ccs. of ice-water is slowly run in from a t funnel with stirring. The large excess acid retards the formation of the diaz amino compound, and the diazonium sol tion is a clear dark brown liquid.

The theoretical resorcinol in 30 ccs. of 2 caustic soda previously cooled in the freezi mixture is then run in from a tap funr with uniform stirring. The first drop of t coupling solution produces a bright red p cipitate. This increases with further ad tion. The solution is stirred a minute two after the completion of the additic and then left for half an hour, and 60 gn of salt are stirred in and the beaker left another half hour or more. The preci tated azo compound is then filtered on t large filter paper and washed with c water to remove salt, etc. The filtrate is bright red in colour. The azo compound dried on the steam.

To completely remove the last traces salts, etc., the dried azo compound warmed for a few minutes with hot wat filtered, washed with a little alcohol, a dried as before. The yield is 9 gms., whi is a little above the theoretical, owing to t retaining of water by the dye, which is o removed after several hours of drying.

The azo compound did not dissolve water or dilute acids, and hence its fastn could not be examined. Its solubility alcohol and acetic acid was slight. It ga with caustic soda solution a deep red so tion, and a similar solution with conc trated sulphuric acid. Hydrochloric a appeared to have no action on the s stance. It was attempted to dye cotton immersion in a boiling suspension in wat hut the experiment was a failure.

1 Phenyl 5 Methylbenzothiazole 4′ Azo Naphthol:

The dehydrothiotoluidine (5 gms.) w weighed out as before, and in this case w dissolved in 40 ccs. of concentrated s phuric acid. The solution was diluted w 100 ccs. of cold water and small lumps ice, the suspension of the sulphate w cooled and diazotized as above, and t theoretical naphthol in 30 ccs. of caus soda run in with the usual precautions. T dye was salted out as in the previous ca filtered, washed, and freed from salts w hot water, filtered and dried. The prod

on the filter paper appeared to be nearly black in colour, and when dry was a shiny solid. During the addition of the naphthol, darkening in colour was noted. Thus, the first drop of coupler produced a bright red precipitate, and this darkened on further addition. The yield was approximately 10 gms. The azo compound exhibited the same lack of solubility of the resorcinol compound, but it dissolved in glacial acetic acid. Concentrated sulphuric acid produces a blue-coloured solution.

1 Phenyl 5 Methylbenzothiazole 4′ Azo β Naphthol:

This azo compound was prepared in the same way as the alpha compound, using the same proportions, etc. It dissolved readily in glacial acetic acid to a red solution, from which a specimen was crystallised. A portion of the azo compound in acetic acid was brominated in the usual way, when a dark red brom thiazole was precipitated in the manner characteristic of these benzothiazoles. The addition, presumably, was of the usual type, consisting of rupturing of the double bond of the fused thiazole ring (*loc. cit.*). The solubility in alcohol was infinitesimal, and the azo compound dissolved in sulphuric acid as in the other cases. The yield was 10 gms.

1 Phenyl 5 Methylbenzothiazole 4′ Azo Salicyclic Acid:

5 gms. of dehydrothtoparatoluidine were diazotized and coupled as in the previous cases, and a brown orange azo compound isolated. Yield: about 7 gms.

The compound dissolves to a red solution in concentrated sulphuric acid, but otherwise exhibits the usual low solubility found in the other compounds.

As has been previously remarked, the insolubility of the compounds is rather remarkable, and may be due in some way to the coupling being carried out in acid solution. Therefore, it is hoped to repeat the above soon, working in alkaline solution, and further, to use the pure intermediate, purified as has been described by the author, since the ordinary intermediate contains a certain amount of the higher homologue, primuline.

The Chemical Laboratory,
Highbury New Park, N.5.
March, 1924.

British Empire Exhibition.

PARTICULARS OF EXHIBITS.

(*Continued from Page 265.*)

J. & J. WHITE, LTD.—(*Continued*).

Oxide of chromium (green) is also produced by the company, and a sample is shown on the stand. It tests over 99.5 per cent., has no carbon in it, and a limit of 0.03 per cent. of sulphur. It is used as a colouring material for paint-making and in the manufacture of ferro chrome and rustless cutlery.

Chromic acid is also shown. It tests over 90 per cent., and is largely used for charging electric batteries.

Bichromate of ammonia is used for making fireworks and in photography.

Sulphate of ammonia is produced as a bye-product. Messrs. White's sulphate of ammonia is well-known and commands a ready sale because it is very regular in strength, testing 25.5 per cent. ammonia, and is dry and neutral.

Various other chrome compounds are shown, but some of them are not of much commercial value, such as trichromate of potash, trichromate of ammonia, chromate of strontium, sesquioxide of chromium, and chromium fluoride. They are interesting, however, as they show a great variety of shades which belong to the chrome compounds.

WILLIAMS, BROTHERS & COMPANY.

Showing a complete range of aniline dyes in the dry form and in solution, as used for a variety of purposes, including leather, confectionery, boot and floor polishes, inks, wood-stains, varnishes, writing-ruling-endorsing and printing inks, soap, wool, silk, cotton, jute, etc., etc. Various skins of leather dyes with specialities, candles and slabs of wax coloured with wax and fat soluble colours, oak panels showing principal wood-stains, custard and egg powders tinted with harmless specialities, etc., etc., and Nigrosine and Induline, of which the firm are the largest and oldest manufacturers in the country.

DUNCAN, FLOCKHART & CO.

The firm's exhibits are classified under three headings: Anæsthetics, Organo Therapy, and Vaccines and Protein Therapy.

Under Anæsthetics they are showing:—

White Label Chloroform, the original and still the most popular of their chloroforms, prepared from ethylic alcohol.

Red Label Chloroform, prepared from industrial alcohol.

Blue Label B.P. Chloroform.

Ether.—Samples of their special anæsthetic ether will be shown. This ether represents the embodiment of all the most recent investigations that have taken place on ether as an anæsthetic.

Ethyl Chloride.—This anæsthetic, so widely used in all minor operations, particularly for children, and also as a local anæsthetic, is shown in the special containers, which are fitted with a patent stopcock adapted for either general or local work.

Organo Therapy.—A wide and interesting range of this modern section of organotherapeutics is on display, showing many of the glands in their raw state as taken from the animals, and the finished product.

Wherever possible, these preparations are subjected to biological testing and standardisation, which is undertaken by the Royal College of Physicians of Edinburgh.

A prominent item is the active principle "Adrenalin" of the suprarenal gland which, in addition, is shown in solution and in ampoule form.

Pituitary fluid is subjected to a very minute and exacting process of standardisation—the method will be readily understood by inspecting the special diagram on view, which portrays concisely the method adopted.

Tablets of thyroid gland, ranging in strength from $\frac{1}{16}$ to $2\frac{1}{2}$ grs. of the dried extract, are shown, and, in addition to the single gland tablets, many multiglandular combinations are shown.

The most notable feature of the glandular tablets is the special soluble coating which effectively protects them from alteration and deterioration, by atmospheric action, a condition to which these substances are extremely prone. They are, on this account, particularly suitable for export.

Vaccines and Tuberculins.—The whole of the firm's vaccines and tuberculins are prepared in the laboratories of the Royal College of Physicians in Edinburgh, and are, therefore, prepared under the latest and most scientific conditions.

They are all primary virulent vaccines, and enjoy an excellent reputation for efficacy and therapeutical results.

All the common vaccines are shown, both for prophylactic and curative purposes. Amongst them is hay fever vaccine, with its complementary ophthalmic test.

It is generally conceded that the comparative disuse into which hay fever vaccine fell, was due to the fact that in many cases a large enough dose of the vaccine was not given to confer immunity, the doseage of the vaccine required to confer immunity varying so much in different individuals.

This difficulty has been overcome by the introduction of the ophthalmic test, which is a guide to the requisite doses for each patient.

Tuberculins, also prepared by the Royal Clolege of Physicians' Laboratory, are shown, as original tuberculins, and in the various dilutions; also examples of the special tuberculin ointment for the percutaneous treatment of tuberculosis, as advocated by Sir Robert Phillip in the *British Medical Journal*, March 24, 1923.

(To be continued.)

GENERAL NOTES.

THE MANUFACTURE OF CARBON BLACK IN CANADA.

Carbon black is a material of considerable importance in the printing ink and rubber industries, both in Europe and America. Its production is practically confined to the North American Continent, where large supplies of natural gas are found.

The name, carbon black, is reserved for the light, fluffy, black powder, formed by the incomplete combustion of natural gas, and the product so obtained has properties which are not possessed by other forms of black such as lamp black or bone black.

Uses.

The fineness of division of the carbon black particles accounts for its great value as a filler in all kinds of rubber goods, such as tyres, boots, shoes, goloshes, soles and heels, hose sheeting, etc. Automobile tyres sometimes contain as much as 20 per cent. of carbon black and it is claimed by many manufacturers that its use greatly increases the strength and life of a tyre.

Carbon black is one of the chief constituents of printing and lithographic inks, yielding an intense black product that cannot be produced from other forms of black. Many ink manufacturers consider carbon black absolutely essential in compounding

an ink that will meet modern requirements.

This material is also a constituent of varnishes and paints, typewriter ribbons and carbon paper, shoe and stove polishes; gramophone records, and almost all articles in which a black filler is used.

Source.

At the present time, British requirements (which amount annually to about ten million pounds) are supplied from the United States. Canadian imports from the same source are about three million pounds. The American carbon black industry is located mainly in West Virginia and Louisiana, but, as many of the gas fields in these States begin to show signs of decline and conservation measures become more restrictive, the industry is seeking new fields.

Canada as a Source of Supply.

Ontario and Alberta are the only provinces in Canada possessing large resources of natural gas. Most of the Ontario fields are declining, however, and the supply is rightly restricted to domestic and industrial heating.

In Alberta, the cities of Calgary, Edmonton and Medicine Hat, and many of the smaller towns are supplied with the cheap natural gas, and in all but a few fields in central or southern Alberta the gas is piped to domestic consumers or is conserved for future demand.

There are four or five natural gas fields in Alberta, however, where the prospects for the establishment of a carbon black industry might be considered. These are the Many Islands Field, near Medicine Hat, the Wainwright Field, one hundred miles east of Edmonton, and the Peace River and Pelican Rapid Fields, in Northern Alberta.

In the Wainwright and Many Islands Fields, while it is believed that extensive gas sands exist, there are few wells drilled at the present time that yield large flows of gas. Another disadvantage is that the gas so far found in both these fields is of poor quality for the manufacture of carbon black and contains little or no gasoline. Transportation facilities are good. It is doubtful if permission would be granted to make carbon black in either of these areas.

Large supplies of gas are known to exist in Northern Alberta, in the Peace River and Athabaska regions. Little reliable information has been collected on its suitability for the production of carbon black or on its gasoline and helium content. Transportation presents some difficulties, though the Peace River Field is served by a good railway. The chief obstacle in the successful establishment of a carbon black plant in either of these areas would be the high freight costs.

It should be borne in mind that the present demand for carbon black is limited, and that the Canadian market could be supplied by the output of two or three plants. Great Britain and the Orient are other possible customers, but the competition with the United States for this trade would be keen.

The International Institute of Agriculture has issued the preliminary programme for the fourth International Conference on "Soil Science" at Rome, May 12-19. Many interesting matters will be discussed, contributions having been received from almost every European country except France.

PROCEEDINGS AND NOTICES OF SOCIETIES.

THE FARADAY SOCIETY.

APRIL 14.

Investigation on the Chemical and Physical Properties of Oppau Ammonium Sulphate-Nitrate at the Government Laboratory, by SIR ROBERT ROBERTSON, K.B.E., F.R.S., GOVERNMENT CHEMISTS, with Appendixes by H. H. THOMAS and A. F. HALLIMOND, and by SIR WILLIAM BRAGG, K.B.E., F.R.S., with an Introduction by SIR RICHARD THRELFALL, K.B.E., F.R.S.

The great explosion at the Oppau factory of the Badische Anilin and Soda Fabrik occurred on September 21, 1921, on the site of a large store containing 4,500 tons of the double salt ammonium sulphate-nitrate, which was the chief product of the factory. The stored salt had set to a rock-like mass, and at the time of the explosion was usually broken up by the use of common blasting explosives. In the course of an enquiry into the possible causes of the explosion, the Chemistry Research Board of the Department of Scientific and Industrial Research found it necessary to have certain special investigations carried out in this country on the nature and stability of the double salt. About a ton of the salt was

obtained from Germany, and investigated very carefully at the Research Department, Woolwich, and at the Government Laboratory. The results of these investigations are of general interest, and the Board have thought it advisable to make them public. A full account is given in the two following papers. Sir Robert Robertson's investigation of the physical condition, and the chemical composition of the double salt disclosed no circumstances which afforded a possible clue of the cause of the explosion. In particular, no evidence could be found in favour of suggestions which have appeared in the Technical Press, that the *presence of certain impurities rendered the* salt sufficiently unstable to be explosive. In the experiments carried out at Woolwich under the direction of Dr. Rotter, it was found impossible to detonate the salt, even under the most powerful compression and *by the use of the most powerful initiators.*

The Board, after careful consideration of these results and of information obtained from other sources, finally came to the conclusion that it was impossible on scientific grounds to arrive definitely at the cause of *the explosion. They had to choose between* three improbabilities, namely,

1. That in spite of the negative character of the Woolwich results, and of previous experiments carried out in Germany, the double salt was capable at least of partial detonation under the extreme conditions of confinement in the store.

2. That through some oversight or accident there existed in the store large pockets of ammonium nitrate either unmixed with ammonium sulphate, or mixed with a proportion insufficient to prevent detonation.

3. That a quantity of 50 to 100 tons of high explosive was concealed deliberately under the store, and that it was the explosion of this material which led to the disaster.

Of these three improbabilities, the Board considered that (2) was the least extreme, and they reported in this sense.

After they had reported, the report of the official German committee of enquiry was published. It is of interest to note that the conclusions of this committee agreed very closely with those of the Board. One circumstance of material importance unknown to the Board is disclosed in this report. It is stated that for some time previous to the explosion the practice of mixing the ammonium sulphate and nitrate in (saturated) solution before drying, had been replaced by the practice of squirting ammonium nitrate on to a conveyor band and adding solid ammonium sulphate by hand. If this is true, it certainly increases the possibility that large pockets of material containing too high a proportion of nitrate were present in the store. It is stated in the report that a mixture containing 70 per cent. ammonium nitrate is capable of detonation.

The chief interest in the enquiry so far as this country is concerned, is as to the safety or otherwise of the double salt if used as a fertiliser. On this point the Woolwich experiments must be regarded as decisive *for anything like reasonable quantities; but* it must be presumed that neither in Germany nor elsewhere will blasting again be resorted to as a means of breaking up solid masses of the material.

Report on Experiments to Determine Whether Ammonium Sulphate-Nitrate as Prepared at Oppau Possesses Explosive Properties, by GODFREY ROTTER, D.Sc., Director of Explosive Research, Research Department, Woolwich.

A large number of tests have been carried out under most diverse conditions, and it has been established that Oppau salt cannot be detonated, even though its temperature be raised to 155° C. and powerful confinement be afforded. It has been shown that a decomposition can be initiated in the salt by means of a charge of explosive or pyrogenic material, and that this decomposition can propagate throughout the bulk at a comparatively low speed. The reaction, however, continues only as long as the confinement is sufficient to retain the heated products in contact with the salt under considerable pressure, a comparatively small leak allowing the decomposition to die out. In the experiments in which this type of decomposition was investigated, the steel containers, when ultimately burst open, presented the appearance of having been ruptured by the application of a slowly increasing gas pressure rather than by the dynamic impulse of an explosive. This type of decomposition involves the ammonium nitrate only, the ammonium sulphate remaining chemically unchanged at the conclusion.

Presuming the silo at Oppau to have contained only the normal salt, it is clear that the explosion cannot have been a detonation set up by the explosive used. It is

possible, however, that the large blasting charges which were being employed were placed so deep and were tamped so securely that they could not blow out, and under these conditions it is conceivable that the decomposition started by their explosion might proceed through a large quantity of salt. It is unlikely that such a reaction could spread very far before venting, and it is highly improbable that the effects produced at Oppau were due to Oppau salt alone.

Note on an Experiment in Solid Diffusion, and its Possible Bearing on the Structure of Solid Solutions, by F. C. THOMPSON, D.MET., B.SC., and W. H. DEARDEN, M.SC.

Two structures have been assumed for solid solutions, the first of these supposes that, as a metal B is added to one A in which it is soluble in the solid, the lattice of the solution is that of the solvent A merely deformed by th eattempt of the two atoms to become of similar volumes. This view offers an adequate explanation of the hardness of these phases. Rosenhain some years later proposed an identical theory, substituting the term "atomic distance" for "atomic volume."

The alternative theory assumes that the added atoms find places in the spaces of the original lattice. Westgren has indicated from his work on the X-ray structure of iron that this view is in better agreement with the density measurements than the earlier one. X-ray work is by no means conclusive on this point, and investigations, *e.g.*, Andrews and McKeehan, both suggest that the lattice of the solvent metal is, for some time, at any rate, still retained with small distortions due to differences of atomic volume. The density of a solid solution is not that which would be expected from the individual atomic volumes.

The experimental work consisted in the determination of the relative rates of diffusion of copper into gold, silver and an alloy of those metals in equal proportions. These materials were chosen since their atomic volumes are almost identical. Both metals were especially pure forms of "fine" metal.

A small pellet of each material was hammered into a smaller hole in a separate block of remelted electrolytic copper. The specimens were then annealed for 70 hours at 650° C. in vacuo and prepared for examination.

In the alloy the width of the diffusion band was very clear, and of the order of 0.075 mm., but in those of the pure metals it was not well shown by etching, and heat tinting was resorted to. The marked increase of the thickness of the band in the pure metal is clear. The actual widths in each case were: Silver gold alloy, 0.075 mm.; silver, 0.15 mm.; gold, 0.23 mm.

Thus, diffusion takes place much more readily into a pure metal than into a solid solution. This is more easily understood on the assumption that the added atoms in the solution are accommodated in spaces in the lattice than if they replace atoms in the lattice itself. It is not intended, however, to insist that this is the case.

(To be continued.)

THE CHEMICAL SOCIETY.

MAY 1.

Paper read:—

Iminodihydro-1:2:3-Triazole. Part II.: Intra Annular Migration of the Dyad Type and Intra Nuclear Tautomerism without Migration, by H. W. CARNELLEY and P. K. DUTT.

SOCIETY OF GLASS TECHNOLOGY.

The seventh Annual General Meeting of the Society was held in Sheffield on Wednesday, April 16, 1924, the President, Prof. W. E. S. Turner, D.Sc., in the chair. Col. S. C. Halse, C.M.G. (Messrs. J. Lumb & Co., Ltd., Castleford) was elected President in succession to Prof. W. E. S. Turner. The other vacancies arising were filled as follows:—

Vice-Presidents: F. G. Clark (Messrs. Beatson, Clark & Co., Ltd., Rotherham), R. L. Frink (Glass Research Association, London).

Members of Council: H. A. Bateson, W. R. Dale, J. Moncrieff, W. J. Rees, B.Sc.-Tech., F.I.C., J. H. Steele, J.P., and H. Webb.

Honorary Treasurer: J. Connolly.

American Treasurer: Wm. M. Clark, Ph.B.

Honorary Secretary: S. English, M.Sc.

Auditors: Ed. Meigh, M.Sc., Dennis Wood, F.S.A.A.

The annual report and accounts for 1923 showed that year to have been a happy and

successful one. The foreign membership continued to increase, numbering 190 out of 615 at the end of 1923. Of these, 109 were resident in the United States. Altogether the Society was connected by membership with no fewer than 17 countries. Prof. Henry Le Chatelier, Paris, was elected an honorary member of the Society. A paper entitled *The Physical Properties of Some Alloys Resistant to Heat and Corrosion* was read by J. H. G. Monypenny, F.Inst.P., and illustrated by lantern slides and specimens. The author dealt with problems which might occur in machinery pertaining to the glass industry, and said there were also certain general engineering uses for material having these special properties, such as the application of the material to various fittings for steam service and hydraulic work.

Dealing first with stainless steel, he outlined the range of properties obtainable, dwelling also on the mechanical and heat resisting properties. Passing on to alloys developed for special properties, the lecturer gave particulars of stainless material in which resistance to mineral acids had been greatly increased, and the tendency for galvanic action in contact with bronze and other copper alloys entirely removed. A short description of some special alloys which had been developed for resisting scaling was given. A sample exposed in a brick kiln for a fortnight, the temperature reaching 1,200° C., revealed a total change in weight of only 0.04 per cent.

The glass industry required alloys suitable for a number of special purposes, in some cases for resisting general corrosion, and in others for resisting the effects of high temperatures. Probably no single alloy would be suitable for all purposes, though for any of those purposes some type of stainless steel would be found useful. For developing any one special property in an exceptional degree, it was generally found necessary to sacrifice other properties to some extent, so that it was advisable for the maker and the user to collaborate.

Mr. W. R. Barclay, A.M.I.E.E., followed with a paper entitled *Some Properties and Possible Industrial Uses of Alloys containing Nickel*. Illustrating his remarks with lantern slides, Mr. Barclay said that he proposed to deal with two alloys, the simple nickel-copper series and the nickel chromium series, with no other metals added. Referring to the nickel-copper alloys, he emphasised their remarkable ductility, combined with considerable toughness and strength, and very considerable resistance to corrosion. A retention of strength at temperatures higher than those at which ordinary non-ferrous metals broke down was particularly evident in the nickel-copper alloys containing high nickel. As an illustration of the enormous ductility, he quoted a recent example of material manufactured, in which it had been possible to cold-work a 2 in. bar right down to 0.02 in. without annealing.

Going on to deal with the nickel-chromium alloys, he pointed out that the two hitherto developed were the 85 per cent. nickel, 15 per cent. chromium, and the 80 per cent. nickel, 20 per cent. chromium. They were remarkable materials, bridging the great gulf that had hitherto existed between ferrous and non-ferrous materials, and combining in a high degree the best properties of both. These were the alloys which had made modern developments of electric heating possible. A very important application of them, which the immediate future would see unquestionably, was their use in annealing furnaces where temperatures up to that order were required.

During the morning an exhibition of special steel and non-ferrous alloys, and of tools and plant made from them, was held in the Department of Glass Technology of the University of Sheffield. The following firms exhibited:—

Messrs. Brown Bayley's Steel Works, Ltd., Sheffield; Messrs. Cronite Foundry Co., Ltd., Tottenham, London; Messrs. T. Firth & Sons, Ltd., Sheffield; Messrs. Foster Instrument Co., Ltd., Letchworth; Messrs. H. Wiggin & Co., Ltd., Birmingham; Messrs. T. G. Wolstenholme & Sons, Sheffield.

The President announced that the next meeting would be held in London on May 27, when a joint conference had been arranged with the British Society of Master Glass Painters. They also expected to welcome on that occasion a party of members from France. The annual dinner would be held on the evening of May 27, in the Hotel Cecil, London.

NOTICES OF BOOKS.

A Text-book of Inorganic Chemistry. Edited by J. Newton Friend, D.Sc., Ph.D., F.I.C. Vol. VII., Part I.: [illegible]

gen, by J. NEWTON FRIEND and DOUGLAS F. TWISS. Pp. XVII. + 370. London: Messrs. Charles Griffin & Co., Ltd., Exeter Street, Strand, W.C.2. 1924. 18s. net.

It was the intention of the editor of this now well-known and invaluable series of text-books to issue Vol. VII. as one part, on the "Elements of Group VI. of the Periodic Classification." This was found impracticable, owing to the voluminous literature referring to these bodies. The first part, which has just appeared, therefore only deals with Oxygen (and ozone, water and hydrogen peroxide). The authors have, however, given an introductory chapter on the general characteristics of the elements of Group VI.

In addition to the accounts of the preparation and properties of oxygen, much useful information has been collected on Combustion and Flame.

The section on ozone is very complete, and mention is made of the occurrence of oxozonides, which point to the existence of oxozone, O_4. The future commercial possibilities of ozone are great, and therefore this section will probably be very widely consulted in the future.

The sections on the atmosphere and water are also very comprehensive. Not only are the physical and chemical aspects of the subject discussed, but their physiological importance is also dealt with.

Some of the technical matters, *e.g.*, the preparation of oxygen by liquefying air, are described very briefly, but as a rule the treatment is good. Very full references and indexes have also been included.

This volume fully maintains the excellent standard of its predecessors.

The article entitled *National Boarding Schools*, by ERNEST REMNANT, which appeared in *The English Review* for March, has been reprinted. The author points out the great advantages to be gained by educating urban children in the country or at the seaside. Such a scheme could not be adopted, of course, without adequate trial, and the author's first concern is to secure a sympathetic consideration for the idea.

The Bulletin of Messrs. Murphy and Sons' Bureau of Bio-Technology, Vol. II., Nos. 11 and 12, contains three papers on matters pertaining to fermentation industries, including one on the genus *Acetobacter* and its relationships, with a very good comparative table of the distinguishing characteristics of the various species. Amongst the other contents is a comparison between three commercial brands of arsenate of lead for horticultural purposes, in which analyses showed all three brands contained 30 per cent. As_2O_4, one brand contained 0.5 per cent. As_2O_3 and 60-62 per cent. PbO, a second brand less than 1 per cent. As_2O_3, and 62 per cent. PbO, and the third 0.65 per cent. As_2O_3 and 60-62 per cent. PbO. It is concluded that the chemical properties give little indication of the insecticidal value, apart from the actual arsenic content.

The current number of the *New Phytologist* (XXIII., No. 1) contains a paper by J. H. Priestley, on "The Fundamental Fat Metabolism of the Plant," dealing with fats and lipins, the distribution of fatty substances in the plant, synthesis of fatty substances at the photosynthetic centres, formation of fatty substances in the meristem, and subsequent utilisation of fats left behind the apical meristem. The paper was written as an introduction to a series of investigations, chiefly concerned with the metabolism of fat in the plant, and contains a statement of the chemical and physiological side of the problem in the hope that chemists and botanists may help towards a solution.

New Patents.

THIS list is specially compiled for *The Chemical News* by Messrs. Rayner & Co., Registered Patent Agents, of 5, Chancery Lane, London, from whom all information relating to Patents, Trade-Marks, and Designs can be obtained gratuitously.

Latest Patent Applications.

8693—Kalle & Co., Akt-Ges.—Process for producing perylenetetracarboxylic acid or its derivatives. April 6.

9163—Lockemann, G.—Manufacture of 1-phenyl-2.3-dimethyl-4-dimethyl-amino-5-pyrazolone. April 10.

9292—Marino, Q.—Process of recovering constituent metals of tin-plate, &c. April 12.

Specifications Published this Week.

186912—Nitrogen Corporation.—Process and apparatus for synthesizing ammonia.

213624—Smith, J. W.—Apparatus for disseminating medicated vapours or crystals.

213643—Taplin, jun., T. J., and Metals Production, Ltd.—Leaching of copper ores containing slimes.

198376—Rhodin, B. E. F.—Electrolytic separation with fused electrolytes.

213486—Carbide & Carbon Chemicals Corporation.—Process of purifying chlorine and other corrosive gases.

Messrs. Rayner & Co. will obtain printed copies of the published specifications and abstract only, and forward on post free for the price of 1s. 6d. each.

[ADVT.]

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William Ackroyd. The Old Light and the New, dealing with the chemistry of colour and new pl (Chapman & Hall.) 1st Ed., 1896. 102 pp. Our Price, 2s.

Jules Aeby. Dangerous Goods. (Crosby, Lockwood & Son.) 1st Ed., 1922. 319 pp. Published

Thomas M. Ainscough. General review of the conditions and prospects of British Trade in Indi Stationery Office.) 1st Ed., 1921. 362 pp. Price, 5s. Our Price, 1s.

Jerome Alexander. Glue and Gelatin. (The Chemical Catalog Co., Inc., New York.) 1st Ed., 19 Our Price, $3.

American Chemical Society Journal, Vol. I. (1879), to 1923. Ditto, Proceedings for the Years 1 Rare and valuable. Our Price, £40.

American Journal of Science, Vol. 27 (2nd series). 1859 to 1923.

American Philoophical Society. General Index to the Proceedings. Vols. 1-50 (1883-1911).

The Analyst, Vol. 1 (1877), and on as issued. Rare and valuable. Our Price, £40.

Leonard Archbutt and R. Mountford Deeley. Lubrication and Lubricants. (Charles Griffin & C 2nd Editions, 1900 and 1907. Our Price, 4s. and 5s.

E. Frankland Armstrong. The Simple Carbohydrates and the Glucosides. (Longmans, Green & and 3rd Editions, 1910 and 1919. 3rd Edition Price, 12s. 6d. Our Price, 6s.

Neil Arnott. Elements of Physics or Natural Philosophy. (Longmans, Green & Co.) 6th Ed. (Price, 8s.

Paul S. Arup. Industrial Organic Analysis. (Churchill.) 2nd Ed., 1920. 471 pp. Price 12s. 6d. 6s.

Ossian Aschan. Die Konstitution des Kamphers. (Brunswick.) 1st Ed., 1903. 117 pp. Our Pri

George William Atkinson. Perfumes and Cosmetics. (Hodder & Stoughton.) 4th Ed., 1919. 38 25s. Our Price, 10s.

Astronomy and Astro-Physics, Vols. 41-43 (1892-4). Our Price, £1.

The Astrophysical Journal, Vol. 1, No. 1, January, 1895 to 1923 (except Vol. 1, No. 3 O.P.) Our

F. W. Atack. The Chemists' Year Book, 1918-1919, 1920, and 1923. Our Prices, 6s., 7s. 6d., 1

E. H. S. Bailey. A text-book of Sanitary and Applied Chemistry. (Macmillan & Co., Ltd.) 1st 1 Vol., 345 pp. Our Price, 3s.

G. H. Bailey. The Tutorial Chemistry. Part II. (University Tutorial Press, Ltd.) 4th Ed., 19 Price, 7s. 6d. Our Price, 3s.

T. Thorne Baker. The Spectroscope. Bailliere, Tindall & Cox.) 2nd Ed., 1923. 208 pp. Price Price, 3s.

Andrew Balfour. First, Second and Third Reports of the Wellcome Research Laboratories at Memorial College, Khartoum (1904-6). 3 Vols.

Wilder D. Bancroft. Applied Colloid Chemistry. (McGraw-Hill Book Co., New York.) 1st E pp. 18s. 0d.

THE CHEMICAL NEWS,

VOL. CXXVIII. No. 3343.

THE STRUCTURE OF SULPHUR.

By Hawksworth Collins.

The constitution of an atom of sulphur was given in *The Chemical News*, this vol., p. 83 (February 8), as:

$$Na—H—H_3—H—H_3—H.$$

The four electro-positive valences emanate from the four portions of the two helium parts, one from each; and the two electro-negative valences emanate from the two portions Na—H of the metallic part of the element.

This was deduced in 1900-03 by reasoning upon the atomic weights and maximum valences of the elements. It will now be proved to be true by means of relative volume and heat of formation.

Table I.

The Relative Volumes of Sulphur.

	S	=	Na — H — H_3 — H — H_3 — H
Common hexad	15.53	=	9.54 + 0.97 + 1.54 + 0.97 + 1.54 + 0.97
Common dyad	10.51	=	9.54 + 0.97 + 0 + 0 + 0 + 0
Rare dyad	7.51	=	6.54 + 0.97 + 0 + 0 + 0 + 0
Amorphous	17.15		

The first two volumes are exactly similar to the first and third of oxygen, as given in the last paper. In the dyads the two helium portions, together with their four valences, have entirely disappeared within the metallic part of the element.

Table II.

Examples Demonstrating the Volumes of Table I.

(71)	As_2S_2 2(19.58) + 2(10.51)	3.5560	3.556	Mohs.
(72)	As_2S_3 (2.19.58) + 3(10.51)	3.480	3.48	Haidinger.
(73)	CaS 12.24 + 15.53	2.59	2.58	Maskelyne.
(74)	$CaSi_2$ 12.24 + 2(13.02)	2.508	2.5	Nostrand.
(75)	Sb_2S_3 2(21.29) + 2(10.51) + 15.53	4.22	4.223	23° Cooke.
(76)	$SbCl_5$ 21.29 + 15.085 + 4(23.01)	2.31	2.316	Chemiker Kal.
(77)	$Fe_2(SO_4)_3$ + $9H_2O$ 2(17.22) + 3(15.53 + 2 × 7.53 + 2 × 2.51) + 9(14.03)	2.10	2.1	Dana.
(78)	FeS 7.05 + 10.51	5.01	5.035 4.75	Playfair & J. Smith.
(79)	FeS_2 7.05 + 10.51 + 7.51	4.787	4.678 4.882	Dana. Neumann.
(80)	K_2SO_4 2(18.05) + 15.53 + 2(7.53) + 2(2.51)	2.43	2.4073 2.572	Hassenfratz. Buignet.
(81)	K_2S 2(18.05) + 15.53	2.130	2.130	Filhol.
(82)	$CaSO_4$ 13.25 + 15.53 + 2(7.53) + 2(2.51)	2.784	2.759 - 2.884	Schroder.
(83)	$CaSO_4$ 13.25 + 15.53 + 7.53 + 3(2.51)	3.102	3.102	Filhol.

The last molecule (No. 83, Table II.) shows that one of the 7.53 volumes of the preceding has diminished to 2.51. This is a common occurrence, which was not known to Thomsen, and therefore put some of his calculations wrong.

TABLE III.

Heat of Formation of Sulphur.

	H.F.						Original Volume		Rel. Vol. in combination 15° C.		Change of vol.
(a)	0	=	120 ×	0	× 32		15.53	=	15.53	+	0
(b)	6217	=	120 ×	1.62	× 32		17.15	=	15.53	+	1.62
(c)	30681	=	120 ×	7.99	× 32		23.52	=	15.53	+	7.99
(d)	49959	=	120 ×	13.01	× 32		23.52	=	10.51	+	13.01
(e)	6217	=	120 ×	1.62	× 32		23.52	=	21.90	+	1.62
(f)	-27494	=	120 ×	(-7.16)	× 32		23.52	=	30.68	-	7.16
	-15530 (gas)										

The last H.F. was obtained from Thomsen's *eleven gaseous sulphur compounds.*

The following paragraphs, (a), (b), (c), (d), (e), and (f) give examples of the six different cases of the heat of formation of sulphur:—

(a) The specific gravity of crystallised S is 2.0605.

2.063 Deville 2.05 Karsten.

32 divided by 2.0605 gives the relative volume 15.53.

If an experiment were made, starting from crystallised sulphur, producing a molecule in which the volume of S is 15.53, the H.F. of that atom would be zero, since there is no change of volume.

E.g., R.V. of $CaSO_4$ is 13.25 + 15.53 + 2(7.53 + 2.51) (No. 82, Table II.).

H.F. of $CaSO_4$ is 59568 + 0 + 2(32341 + 96155) = 316560 317400 (obs.).

The connection between the values for Ca was given in *The Chemical News*, 1922, CXXV., 82 (Aug. 18).

(b) If an experiment were made, starting from amorphous sulphur of S.G. 1.866 (1.87 Muller), and therefore of original volume 17.15, producing a compound in which the volume of S is 15.53, the H.F. of that atom would be 6217, since its volume has diminished from 17.15 to 15.53.

E.g., R.V. of $Fe_2(SO_4)_3 + 9H_2O$ (No. 77, Table II.) is 2(17.22) + 3(15.53 + 2×7.53 + 2×2.51) + 9(14.03).

H.F. aq. 2(-69000) + 3(6217 + 2×32341 + 2×96155) = 651627 650500 (obs.).

-69000 = 120 × (-10.27) × 56 and 17.22 - 10.27 = 6.95.

This is the same original volume as that obtained previously (*loc. cit.*).

The above examples show the state of affairs with regard to sulphates, and fall in exactly with the law of heat of formation; but the H.F. of sulphides and of the molecules, SO_2 and SO_3, must have been obtained in a different manner. There are four distinct cases, c, d, e, and f, all leading *to the same conclusion, viz., that the* original volume of the sulphur atom was 23.52, giving the S.G. 1.36, of which, however, there is no experimental confirmation. Otherwise everything is correct.

A similar remark was made in *The Chemical News*, 1922, Aug. 25, with regard to lithium. The only S.G. that appeared to be given was Bunsen's 0.578, whereas the required value was 0.534. It was afterwards found that Van Nostrand gave 0.534 as the S.G. of lithium.

(c) If an experiment were made starting from sulphur of S.G. 1.36, producing a sulphide in which the volume of S is 15.53, the H.F. of that atom would be 30681, since its volume has diminished from 23.52 to 15.53.

E.g., H.F. of CaS is 64420 + 30681 = 95101 94300 (obs.). This corresponds exactly with No. 73, Table II., as shown in *The Chemical News*, Aug. 18, 1922.

(d) If an experiment were made starting from sulphur of S.G. 1.36, producing a sulphide in which the volume of S is 10.51, the H.F. of that atom would be 49959, since its volume has diminished from 23.52 to 10.51.

E.g., H.F. of Sb_2S_3 is 2(-48200) + 2(49959) + 30681 = 34199 34400 (obs.). This corresponds exactly with No. 75, Table II., as shown in *The Chemical News*, 1922, Aug. 18.

(e) R.V. solid SO_3 21.9 + 2(7.53) + 4.45 1.932 1.940, 16° Weber. 1.91, 25° Buff.

H.F. aq. SO_3 6217 + 2(32341) + 71515 = 142414 142410 Thomsen.

R.V. liq. SO_3 21.9 + 3(7.53) 1.80 1.81, 47° Buff.

H.F. liq. SO_3 6217 + 3(32341) 103240 103240 Thomsen.

The H.F. of the solid is not given, but H.F. aq. frequently corresponds with the rel. vol. of the solid, as here and also in (b).

It is evident from the above that when SO_3 passes from the liquid to the solid state, only one of the four atoms is affected. This is also a frequent occurrence.

From Table III. (e) the original volume of S is again 23.52.

(f) R.V. liq. SO_2 30.68 + 2(7.53) 1.40 1.4017, 11°.5 d'Andreeff.

H.F. gas 18° C. of SO_2 6217 + 2(32341) = 70899 71080 Thomsen.

H.F. aq. SO_2 −27494 + 32341 + 71515 = 76362 H.F. liq. 77280 Thomsen. H.F. aq. 78780 Thomsen.

From Table III. (f) the original volume is again 23.52.

A FUNDAMENTAL DISCOVERY.

It had been intended to omit mention of *the following observation until it had been* supported by more evidence, but it seems *wiser, for certain reasons, to state it now.*

The heat of formation in large calories of an element is frequently equal either to a relative volume of the same element, or to a relative volume multiplied by a digit, which probably represents a valency of the element.

In Table III. there are two cases of this:

15.53 is a volume of S, and

−15.53 is a value for the heat of formation in large calories.

30.68 is a volume of S, and

30.681 is a value for the heat of formation.

(The difference between negative and positive heat of formation is that the former denotes increase of volume and the latter decrease.)

The probability against a double event like this happening accidentally in a table where there are only seven values of H.F. and the same number of volumes given can be shown to be more than a million to one; so that it is absolutely certain that there is no accident in the matter. It is impossible for the observer to prove that each of these two cases corresponded, as they did, exactly to four figures before the discovery was made, but that does not matter because there are many other similar coincidences ready for publication. One has already appeared in the case of vanadium (*The Chemical News*, this. vol., Feb. 15.):—

17.76 is a volume of vanadium, and −53305 the heat of formation. 53305 divided by 3 = 17768.

As this is evidently a deep-seated discovery, the cause of it must be fundamentally important. In any case, the observation is an absolute proof that these papers contain very exact deductions.

SUMMARY.

In this, and preceding and following papers, experimental data are being employed to demonstrate that the structure of each element, as previously obtained and published in *The Chemical News*, from July 18, 1919, to Nov. 5, 1920, is correct.

These operations involve the demonstration of—

(1) *The Law of Heat of Formation.*—The heat of formation of an element is proportional to the product of the atomic weight and the change of volume; there being two distinct series, the sodium elements and the sub-sodium elements.

(2) *The Law of Relative Volume.*—The relative volume of an atom is the sum of the relative volumes of its parts, any one or more of which may be zero.

(3) The observation that the heat of formation in large calories of an element is frequently equal to a simple multiple of a relative volume of that element.

(4) The conversion of Specific Gravity into an exact Instrument of Research.

A STUDY OF SOME OXY-SALTS OF THE ELEMENTS IN GROUP VI., PERIODIC CHART.

By GEOFFREY N. RIDLEY.

Of the eight elements residing in Group VI., at least six form well-defined compounds of the general formula:

$$MeO_2 < {R \atop R}, \text{ where } R = \text{monovalent radical.}$$

As a series they present an interesting gradation in their properties, best shown when tabulated. Chromium and uranium are two good representatives of the group.

CHROMIUM.

Chromyl Chloride.

With chromium is associated the well-known chromyl chloride, CrO_2Cl_2, which may be prepared in a variety of ways. That most quoted in text-books is to treat a mixture of sodium chloride and potassium dichromate with strong H_2SO_4;

on heating the mixture, chromyl chloride distils over. Precisely the same result is obtained if chromium trioxide is substituted for the dichromate:

$$CrO_3 + 2NaCl + H_2SO_4 = Na_2SO_4 + CrO_2Cl_2 + H_2O.$$

At first sight it would appear that it is necessary that the HCl should be generated within the sphere of reaction. This is not so since the mere treatment of CrO_3 with concentrated HCl and a relatively small amount of H_2SO_4 is quite sufficient to throw off the heavy red vapour of chromyl chloride, which immediately condenses to a deep red liquid. In fact, the oxide and the HCl react alone to give the chloride, but owing to the simultaneous formation of water a reversible reaction is instituted, preventing the appearance of the compound:

$$CrO_3 + 2HCl \rightleftarrows CrO_2Cl_2 + H_2O.$$

In the actual preparation of the compound by the dichromate and sodium chloride method, the chromyl chloride first appears at about 25-30° C., this temperature being obtained from internal sources. The very first products of the reaction are HCl and Cl_2. Later the temperature rises when the chloride distils over at a maximum rate at about 122.5° C.

The reaction on the whole is somewhat complex, there being several decomposition products formed, which pass over with the chromyl chloride.

Chromyl Bromide and Iodide.

In the case of these two elements it has been shown that both refuse to take up the position of the OH groups in chromic acid. Both bromine and iodine are relatively inactive with regard to hydrogen; fluorine is even more active in this respect than chlorine. Hence it should form a very definite fluoride compound.

Chromyl Nitrate.

Chromyl nitrate is not found as the final product when sodium nitrate and potassium dichromate are distilled together with conc. H_2SO_4. The nitrate may possibly be formed at some stage in the process, but is subsequently broken up by heat, the amber coloured liquid which distils over being merely nitric acid containing a certain amount of dissolved oxides of nitrogen.

$$2CrO_3 + 2HNO_3 + 3H_2SO_4 = Cr_2(SO_4)_3 + 4H_2O + 2NO_2 + 2O_2.$$

If the vapour of nitric acid is passed over warmed CrO_3, a red oily liquid soon forms on the walls of the tube, and this may actually be the nitrate:

$$CrO_2 < \begin{matrix} NO_3 \\ NO_3 \end{matrix}$$

Nitric oxide in contact with heated CrO_3 gives nitrogen peroxide, while the CrO_3 is partially reduced to the dioxide, CrO_2.

The preparation of the nitrate is made more difficult than the formation of the chloride, since there is a constant liability for the nitrate radicle to break up when in contact with a powerful agent like chromium trioxide. For this reason the nitrate compound is likely to be more easily prepared by a more synthetical process, if such is possible.

URANIUM.

Among the rare elements of this group, uranium presents some characteristic features with regard to these compounds of the type:

$$MeO_2 < \begin{matrix} R \\ R \end{matrix}$$

Uranyl Chloride.

As with chromium we have the trioxide UO_3. This oxide is a yellow solid, dissolving in HCl to give uranyl chloride:

$$UO_2Cl_2.$$

Uranyl chloride may also be prepared by passing chlorine over a heated mixture of carbon and uranium oxide.

Uranyl Nitrate.

Here, in contrast to chromium, we get a well-defined nitrate compound. It is formed when uranium or the oxide is dissolved in HNO_3:

$$UO_2(NO_3)_2.6H_2O.$$

It is a solid, yellow and crystalline. When kept at a temperature of about 250° C. for some time, it breaks up into UO_3, thus showing it to be a stable compound.

Uranyl Sulphate.

This compound forms yellow crystals of the composition:

$$UO_2{=}SO_4.3H_2O.$$

GENERAL CONSIDERATIONS.

The states of these compounds form a very remarkable series with the doubtful case of the gaseous oxide of chlorine at the top and the solid compounds at the bottom, reached by stages of transition.

Elements.	At. Wt.	MeO_2R_2.	State.	Remarks.
Oxygen.	16	OO_2Cl_2	Yellow gas.	Unstable.
Sulphur.	32	SO_2Cl_2	Colourless liquid.	SO_3 extremely active with water.
Chromium.	52	CrO_2Cl_2	Heavy red liquid.	CrO_3 fairly active with water.
Selenium.	79.2			
Molybdenum.	96	MoO_2Cl_2	Solid (?)	MoO_3 insoluble in water.
Tellurium.	127.5			
Tungsten.	184	WO_2Cl_2	Yellow solid.	WO_3 insoluble in water.
Uranium.	238	UO_2Cl_2	Solid.	
		$UO_2(NO_3)_2$	Yellow crystals.	UO_3 insoluble in water.
		$UO_2=SO_4$	Yellow crystals.	

The trioxide of the element which forms the basis of these compounds also shows a gradual differentiation in properties in each case, and these particular properties are undoubtedly correlated with the varying aptitude of the elements for forming these compounds of the type:

$$MeO_2\ (R)_2.$$

A NEW METHOD OF DETECTING COBALT AND NICKEL SEPARATELY OR IN PRESENCE OF EACH OTHER.

By C. C. PALIT, M.Sc.

DETECTION OF COBALT SALT.

If a dilute solution of cobalt salt is taken and a saturated solution of sodium bicarbonate is added, a light pink precipitate is obtained which dissolves on the addition of excess of sodium bicarbonate to a light pinkish solution. If bromine water or any other oxidising agent is added to it, an apple green colour is obtained in the cold on shaking. By this method we can detect 0.000025 gm. of cobalt in 10 cc. of the reaction mixture. Hydrogen peroxide, bleaching powder, chlorine water, etc., can be used as well instead of bromine.

DETECTION OF NICKEL SALT.

If a few drops of dilute solution of nickel salt be taken and a saturated solution of sodium bicarbonate be added to it, a light green precipitate is obtained which does not dissolve by the addition of excess of sodium bicarbonate. If now bromine water be added and warmed, a blue black precipitate is immediately obtained which colours the sides of the test tube, *i.e.*, a thin bluish black film is formed inside the test tube. The blue black colour is not obtained in the cold. By this method we can detect 0.000020 gm. of nickel in 10 cc. of the reaction mixture.

Detection of Cobalt and Nickel in Presence of Each Other.

If a few drops of dilute solutions of nickel and cobalt salts be taken in a test *tube containing a saturated solution of* sodium bicarbonate and a drop or two of bromine water be added to it, an apple green colour is produced on shaking in the cold. This indicates the presence of cobalt. Now heat the solution, and a bluish black colour is obtained, and a colouration is produced inside the test tube. Satisfactory results are obtained when saturated solutions of sodium bicarbonate are used and only a few drops of bromine water. Experiments have been made with a large excess of either of the ingredients, namely, cobalt or nickel salt, and no interference was observed due to the presence of excess of either substance. These tests are certainly as sensitive as the existing tests for nickel and cobalt, but undoubtedly these tests are much better and more convenient to perform than the cyanide method of separation of nickel and cobalt.

The reactions involved are presumably as follows:—

When we add sodium bicarbonate to a cobalt salt, we get cobalt carbonate precipitated which dissolves in excess forming a complex carbonate of the type $Na_4Co(CO_3)_3$, akin to $Na_4Co(CN)_6$. This complex sodium cobalto carbonate is pinkish in colour. If bromine water or any other oxidising agent is added to it, it passes into the stable apple green sodium cobalticarbonate, $Na_3Co(CO_3)_3$, just as *sodium cobalto cyanide*, $Na_4Co(CN)_6$ passes into sodium cobalticyanide, $Na_3Co(CN)_6$. This complex cobalti carbonate is stable, and is like other complex cobaltic salts, namely, cobalti acetate, cobalti tartarate, cobalti oxalate, cobalti citrate, cobalti nitrite, etc., and hence sodium cobalti carbonate does not decompose, even on boiling. (Compare Durrant, *Proc. Chem. Soc.*, 1896, XII., 244; *Trans. Chem. Soc.*, 1905, LXXXVII., 1781).

On the other hand, nickel, which is well known not to be capable of forming a complex nickelicyanide or nickelinitrite, cannot also form a complex nickelicarbonate. On *the addition of sodium bicarbonate to a* nickel salt a light green precipitate of nickelous carbonate is formed which does not dissolve in excess. If bromine water is now added and heated, the carbonate [illegible] hydrolysis and partly becomes *nickelous hydroxide*, which is readily oxidised into the bluish black nickelic hydroxide, which is a well known compound of nickel in the trivalent condition.

Instead of bromine water, the following oxidising agents have been used with similar results, viz., chlorine water, bleaching powder, both emulsion and solution, etc.

My best thanks are due to Dr. N. R. Dhar, D.Sc., for his valued suggestions and interest he has taken in connection with this investigation.

Chemical Laboratory,
Allahabad University,
India.

British Empire Exhibition,

PARTICULARS OF EXHIBITS.

(*Continued from Page* 282.)

Duncan, Flockhart & Co.—(*Continued.*)

Protein Therapy.—Much interest has been shown in protein therapy which has *had excellent results, not only in asthma,* but in such conditions as urticaria, epilepsy and angio-neurotic oedema.

It is a known and accepted fact that in certain cases of bronchial asthma, paroxysms follow the ingestion of particular articles of diet, or exposure to the odour of certain animals.

Research has discovered that certain individuals have a peculiar susceptibility to the toxins of certain plants and vegetables, and of animal hair, fur, etc.

Following up this discovery, the firm have successfully prepared vaccines from a very wide range of all these known toxins, and patients are vaccinated and successfully treated, on the same lines as with a bacteriological vaccine.

Tests are also prepared for successfully determining which particular toxin the individual is suffering from.

Collaterally, the peptone treatment is of interest. Ampoules of peptones are on view.

This product, with its graduated dosage, is of special value in the treatment of spas*modic asthma, where it may be inconveni*ent to carry out the protein treatment. It is used hypodermically, and by means of its desensitising action, the protein shock is first greatly lessened, and eventually completely worked off.

THE ERASMIC CO., LTD.,

are making a most distinctive exhibit. Their products, which are household words throughout the whole world—"Peerless" Erasmic Soap and Erasmic Shaving Sticks—naturally occupy a prominent space, but the more recent productions make a most pleasing display.

It is interesting to record the wonderful success this company has attained. "Peerless" Erasmic Soap has won greater popularity than any other soap ever made, the secret of this no doubt being due to its purity, fascinating perfume, and the wonderful properties which it contains for soothing and beautifying the skin. It contains no dye, the delightful purple colour being obtained from a very rare herbal root which gives to the soap those soothing, healing and beautifying properties, so that even the water in which the soap has been used is in itself a lotion of inestimable value to the skin.

The actual cost of manufacture of this soap is higher than any other soap made. It is not generally known that the wonderful semi-transparent effect which will be observed when the soap is held in front of a strong light, is obtained not by any artificial process but by milling.

This company have recently built one of the finest factories of its kind in the world, and all their soaps, perfumes and specialities are being made on the very latest and most up-to-date methods.

The Erasmic Co. are holders of the highest possible awards at all recent exhibitions, including the Hors Concours at the Brazilian (Rio de Janeiro) Centenary Exhibition, 1923, and as South Americans are recognised as the largest users of perfumery, the award itself is sufficient to speak of the inestimable value placed on the perfumes of "Erasmic" by those connisseurs.

"Roman Bath" Soap.—Among the most recent productions which give such a striking appearance to their exhibit, is a new bath soap in a novel shape, and new perfumes. We must say that we consider this a long-felt want, the tablet being made such a shape that it does not slip out of the hand, and wears to the very thinnest wafer. Being made in six perfumes, there is a scent to suit the most fastidious.

"Kiddy Soap."—A line worthy of the highest congratulation. The design, as everyone will observe, is one by the famous artist, Miss Mabel Lucie Attwell.

Great care has been taken in the manufacture of this specially prepared soap for the delicate skins of infants; therefore, it may be used by those who are unable to use ordinary soaps.

"Black and Gold" Series.—These are another of the recent productions of this company. They are so beautifully produced (the design itself being copied from an antique Chinese cabinet), which gives one the impression that the containers are actually made by Old Masters in the art of lacquering. The series include:—

Talcum powder, vanishing cream, poudre compacte, solidified dentifrice (an innovation), transparent solidified brilliantine (a unique product), bath salts, compressed bath salts, baby powder, shaving powder, shaving cream, lip stick.

One will also observe among a few of the leading series in this exhibit, "Himalaya Bouquet," a perfume reminiscent of the East, and of which more than half a million bottles were sold during 1923.

"La Reine d'Egypt," a mystifying perfume of ancient Egypt. "Trishna," a perfume of delight. "Gloria," an entrancing odour as graciously accepted by H.M. the Queen on the occasion of Their Majesties' visit to the Erasmic Works. "Lora," an elegant odour. "Belle de Nuit," a charming series. "Red Rose of Lancaster," a great favourite, etc., etc.

It is interesting to note that The Erasmic Co., who are the largest makers of shaving soaps in the Empire, have recently introduced a new shaving cream in their "Black and Gold" series. Much time and thought has been expended in their laboratories in the production of this article, and there is no doubt that the product is worthy of trial as it is a preparation of unique properties which will give the most deligthful shave it is possible to have.

You will be able to obtain from the attendants at the stand, charming souvenir caskets, on which is embossed a picture of the Erasmic Bubble Fountain, which is such a striking edifice near their stand. These boxes contain various soaps and toilet preparations, and are sold at a nominal charge.

NEWTON, CHAMBERS & CO.'S

stand represents Izal Germicide, which is "used the world around," and throughout the Exhibition. This stand is an original conception. In the centre of the exhibit there rises a central pylon supporting a huge bottle containing Izal. This bottle

is supported upon an illuminated glass stand, showing silhouettes of Messrs. Newton, Chambers & Co.'s Collieries, Chemical Works, Iron Works, etc. The pillar which supports these springs from those two commodities (coal and iron) which have contributed so greatly to the wealth of the Empire, thus at the same time symbolising the other interests of this old-established firm (founded in 1793).

An illuminated representation of the world as a globe is found at each corner of the exhibit, and it would appear that Izal is overflowing from the bottle, running in streams to every quarter of the globe. The world cannot get enough Izal. In the show cases there is a representative array of other products manufactured by this company.

Jeyes' Sanitary Compounds Co., Ltd.

The pre-eminence of coal tar disinfectants is due to great stability, high germicidal strength, and relative non-toxity.

Germicidal strength is not only dependent on chemical properties, but is a function of certain physical properties, viz., the power of forming a perfect and stable emulsion with water.

There are two distinct classes of coal tar fluids—black and white. The oldest and best known of these are the former, which are typified by Jeyes' Fluid and Cyllin. On pouring into water they yield milky-white emulsions, produced by the scattering of light from the surfaces on an enormous number of ultra-microscopic particles.

The white fluids, as exemplified by Jeyes' White Cyllin, are produced by the mechanical emulsification of certain phenolic constituents of the higher coal tar fractions in the presence of traces of stabiliser. This process is in operation by the model on the stand, and the fluids thus produced have a potency equal to that of the black fluids.

Black fluids are stable over a wide range of temperature, whereas the white fluids, whilst possessing the property of miscibility with salt and brackist water, are demulsified at the freezing point of water.

The standardisation of disinfectants is effected by the now almost universally adopted Rideal-Walker test. The apparatus used in connection therewith is demonstrated on the stand.

In addition, several medical and domestic sanitary preparations are shown, including a novel vaporiser, employing a pleasant smelling compound of high Rideal-Walker efficiency.

Cultures on Agar from town air and other sources of infection are also shown.

Scottish Dyes, Limited,

are exhibiting in bottles their well-known dyes of the Solway Blue B. and *Celatene series*.

In addition, specimens of the intermediates such as anthranilic acid, anthraquinone, dichlor iso dibenzanthrone, methylamine hydrochloride, naphthanthraquinone and phthalic anhydride, are being shown.

The main feature, however, of their stand will be the textiles dyed and printed with these colours. They specialise in vat colours of the anthraquinone series for cotton and silk dyeing, and acid alizarine colours for wool dyeing.

Spencer, Chapman & Messel, Ltd.

The Exhibit will be enclosed in an oval glass case mounted on a mahogany base, and will consist of a centre show bottle containing SO_3 crystals surrounded by exhibits of 20 per cent., 40 per cent., 60 per cent., 80 per cent. oleum, and H_2SO_4.

Framed charts, mounted on easels, will also be exhibited, showing the curve and table of the melting points of sulphuric acid and oleum.

(To be continued.)

INSTITUTE OF METALS AND THE EMPIRE EXHIBITION.

Novel Exhibit of Non-Corrosive Coloured Aluminium.

Intended primarily for the use of visitors to the British Empire Exhibition, the Institute of Metals has prepared a special booklet, which, when bearing a visitor's signature, serves as a card of introduction to the meetings of the Institute and to the Library of the Institute during the period of the Exhibition. This valuable facility is intended to appeal primarily to overseas visitors, who can obtain copies of the booklet either through their respective High Commissioners' Offices in London, from the Secretary of the Institute of Metals, Mr. G. Shaw Scott, M.Sc., 36, Victoria Street, S.W.1, or at the Exhibition, on Stand No. 237, Palace of Engineering.

The distribution of the booklet is not restricted to overseas visitors, and copies can be obtained by anyone interested upon application being made in writing to Mr. Shaw Scott at the above address.

The next election of members of the Institute of Metals is due to take place on May 14. Persons then elected—their first subscriptions covering the specially extended period ending June 30, 1925—will be entitled to take part in the first Empire Mining and Metallurgical Congress (to be held at Wembley from June 3 to 6), and in the London meeting of the Institute, to be held in connection with the British Empire Exhibition, from September 8 to 11.

On Stand No. 237 at the Exhibition—that of the Non-Ferrous Metal Trades Joint Committee—the Institute of Metals has a unique display in the scientific section, illustrative of the corrosion of condenser tubes. The exhibit includes coloured diagrams showing sections of tubes and the scales which are formed upon them in sea-water. The diagrams prove that the rate of corrosion of the tubes is mainly dependent upon the properties of the scale. A set of diagrams gives the reactions, as a result of which scales are formed. The ways in which the scales may break down locally, and so give rise to pitting, are also illustrated. Actual tubes taken from commercial condensers are shown to illustrate each type of corrosive action. A novel method is shown for protecting aluminium from the action of sea-water, especially under conditions in which the aluminium is liable to be alternately wetted and dried. A remarkable series of specimens is shown of aluminium protected by this method. A means has been found whereby aluminium can be rendered not only resistant to corrosion, but also—and at the same time—can be coloured, thus making the metal particularly suited for decorative purposes. The possibilities in front of the new process are vast. Thus, coloured aluminium in thin sheets, used in place of wall-paper, would last for years, and could be washed down to an unlimited extent; similarly, coloured aluminium panelling could be used in the construction of motor car bodies, replacing paint work.

GENERAL NOTES.

BRITAIN'S GREATEST TRADE YEAR.

OPENING OF THE TENTH BRITISH INDUSTRIES FAIR.

Britain's greatest trade year reached its height with the opening of the British Industries Fair at the White City last week. On its close, the Birmingham section will open in its turn, and also remain open for two weeks.

The British Empire Exhibition, which was opened a fortnight ago, is rightly described as *the Empire's shop window*. The British Industries Fair is equally well described as its business office. While the general public of the United Kingdom, the Dominions and the countries of the world are examining the Empire's products at Wembley, trade buyers from all quarters of the globe will be found at the British Industries Fair ordering their stocks of British goods for their ensuing year's trade.

The present Fair is the tenth of an unbroken series. First organised in 1915, with no thought of repetition, it proved of such value to both manufacturers and buyers, that it has become an annual feature in British business circles. It is organised each year by the Department of Overseas Trade, and in addition to being self-supporting, it is, in its many businesslike features, quite unlike any other event of its kind held in the Empire.

Buyers come each year in increasing numbers from all over the world, and the most comprehensive organisation exists for their assistance. Probably the most valued is that representatives of the Department of Oveseas Trade are in attendance to put them into direct touch with representative firms in any of the industries in which they are interested. There is also a corps of interpreters, all of them ex-officers, equipped to deal with all language problems. In addition, there is a club for their use throughout the duration of their visit, and information bureaux where trade enquiries of every kind can be dealt with by experts in every industry represented at the Fair. Needless to say, however, enquiries cover every imaginable subject, and are not restricted entirely to business.

An important feature of the Fair is the attention paid by the exhibitors to the needs of overseas markets. This year many new lines specially adapted for overseas requirements, have been evolved after considerable research, and should play a great part in securing additional trade for the nation's exporting firms. It is the custom, too, of exhibitors to select the Fair for the first display of their new lines and novelties, and this will be especially so this

year, as a record attendance of buyers is expected.

A fact which is of considerable value to the trade buyers is that all exhibits are under one roof, so enabling goods of all grades to be compared with a minimum of time and trouble.

The elimination of trouble for the buyer is the keynote of the whole organisation, and as such, is typical of modern business methods. In the past it was sufficient to leave the work of buying to the buyer, but the changed conditions of commerce make it imperative to-day that the producer shall possess an active selling organisation. With this fact in view, the organisers of the British Industries Fair leave nothing to chance to ensure that buyers and sellers shall be brought together at the Fair and that business shall result between them.

Business men can obtain tickets of invitation from the Department of Overseas Trade, 35, Old Queen Street, Westminster, S.W.1.

PROCEEDINGS AND NOTICES OF SOCIETIES.

THE FARADAY SOCIETY.

APRIL 14.

(*Continued from Page* 285.)

The Photochemical Decomposition of Gaseous Sulphur Dioxide, by R. ASHTON HILL.

The decomposition of sulphur dioxide gas under the action of light radiated from a uviol mercury vapour lamp has been investigated, and the resulting photostationary state, characteristic of a given set of conditions, determined, using a number of different light filters.

The primary photochemical process may either be a dissociation of the SO_2 molecule into atomic sulphur and molecular oxygen, or may simply consist in the activation of a SO_2 molecule. In either case the final result is expressed:—

$$3\ SO_2 = 2\ SO_3 + S.$$

The wave-length chiefly responsible for such decomposition of the gas is 313$\mu\mu$. It is noteworthy that the shorter wave-lengths, also present in the above source of radiation, contribute very little to the decomposition. The wave-length 313$\mu\mu$ lies within the first absorption band of sulphur dioxide (at a pressure of 600 mm.), but does not correspond with the head of the band, already known to occur at 296.1$\mu\mu$. The actual wave-length producing maximum decomposition depends on the nature of the source of radiation, *i.e.*, upon the intensity distribution of the emission spectrum.

Of the radiation emitted from the uviol lamp the longest wave-length capable of decomposing sulphur dioxide is the 313$\mu\mu$ line itself. The conclusion is drawn that any wave-length within the absorption band of the substance is capable of bringing about decomposition provided the intensity is sufficiently great.

The bearing of the photochemical decomposition of sulphur dioxide upon the critical increment of the *thermal* union of oxygen and sulphur vapour is discussed. It is concluded that the molecule S_2, as distinct from the atom, is involved in this process.

The Repair of Worn Components by Electro-Deposition, by CAPTAIN J. P. McLARE, B.Sc., A.M.I.E.E., R.A.O.C.

The application of the process of electro-deposition to the repair of worn parts of machinery is generally understood to have been conceived during the late war by technical officers of the Royal Flying Corps in France, who were compelled by the grave shortage of new spare parts to explore carefully any avenue which might lead to the salvage of components which would otherwise have to be scrapped on account of wear. The feasibility of the idea was speedily recognised by officers of two other branches of the Service, namely, the Royal Army Service Corps and the Royal Army Ordnance Corps, responsible respectively for the maintenance and repair of motor transport vehicles and of ordnance stores, the latter including guns and howitzers of all descriptions. Experiments were consequently made in the workshops in the field of each of the three units mentioned with considerable success, and a large number of valuable mechanisms were thereby repaired and put back into service.

The experiments were followed up at home by an electro-metallurgical committee, set up in connection with the Ministry of Munitions, who had at its disposal the services of eminent scientists whose experience and expert knowledge enabled great progress to be made.

A brief description of the development of

the process from the time of its inception to the termination of hostilities was given. Examples of the type of work carried out were described.

Conditions of the Appearance of Anode Effect in the Electrolysis of Fused Chlorides, by THOMAS ARTHUR HEPPENSTALL and WILLIAM JAMES SHUTT.

The aim of this work is to extend our knowledge of the phenomena occurring at the anode in the electrolysis of fused salts by a study of the conditions governing the appearance of anode effect. Having proved the reproducibility of anode effect at constant current density and determined the value of the limiting current density (and its variation with temperature), it was proposed to examine the effect of superimposition of alternating current upon the direct current used for electrolysis.

In the small scale electrolysis of fused salts, the difficulties of obtaining steady and reproducible conditions are considerable, and a great amount of preliminary work was necessitated. During the course of these early experiments several fused electrolytes and several types of apparatus were tried, with varying success; it was established, however, that, with fused potassium chloride and fused zinc chloride, anode effect was reproducible at approximately constant current density. This result seemed to warrant further investigation, and the following is an account of the method finally adopted as most suited to give conditions of electrolysis which could be easily and accurately controlled. Temperature was readily adjusted, and the method gave entire satisfaction in the cases of potassium chloride, zinc chloride and, to a certain extent, lead chloride. The results obtained were readily reproducible throughout the course of the work.

Curves showing the variation of limiting anodic current density with temperature have been obtained for the cases of fused potassium and zinc chlorides. In the case of lead chloride, one figure only is given. This value relates to a temperature near the melting point of the salt.

From results of experiments in which alternating current was superimposed upon the direct current used for electrolysis, it was observed that the alternating current had the effect of producing anode effect at a

THE ROYAL SOCIETY OF ARTS.

On May 5, a paper entitled *Photography in Industry, Science and Medicine*, was read by T. THORNE BAKER.

On May 7, at the Ordinary Meeting, a paper entitled *Wireless Navigation of Ships and Aircraft*, was read by J. ROBINSON, M.Sc., PH.D., F.INST.P., Head of Wireless and Photographic Department, Royal Aircraft Establishment, Farnborough. Admiral of the Fleet, Sir Henry Jackson, G.C.B., K.C.V.O., F.R.S., presided.

INSTITUTE OF CHEMISTRY OF GREAT BRITAIN AND IRELAND.

PASS LIST, APRIL EXAMINATIONS, 1924.

The following candidates have passed the examination for the Associateship:—

In General Chemistry.—Robert Paterson Balfour, Heriot-Watt College, Edinburgh; Clifton William Gibby, University College, London; Frank Joseph Green, B.Sc. (Lond.), West Ham Municipal College; Guy Warwick Harrison; Alexander George Laing, B.Sc. (Edin.), Heriot-Watt College, Edinburgh; Geoffrey Lailey McCarter, Royal Technical Institute, Salford; Leslie Burt Milne, Sir John Cass Tech. Institute; Charles Frederick Myers, B.Sc. (Lond.), Huddersfield Technical College; James Leith Philp, Heriot-Watt College, Edinburgh; William Ewart Wright, King's College, London.

Under Regulations prior to March, 1920; In the Chemistry, including Microscopy, of Food and Drugs and of Water.—Cyril Wheatley Maplethorpe, School of the Pharmaceutical Society.

The following candidates have passed the examination for the Fellowship:—

In Branch D: Agricultural Chemistry.—Bhagavatula Viswanath.

In Branch E: The Chemistry, including Microscopy, of Food and Drugs, and of Water.—George Marshall Norman, B.Sc. (Lond.), A.R.C.S.; Russell Gibson Thin, B.Sc. (Edin.).

In Branch H: General and Analytical Chemistry.—Clifford Hollingsworth.

INSULIN.

At a meeting of the Manchester section of the Society of Chemical Industry, held

on May 2, in the Textile Institute, Dr. ARNOLD RENSHAW read a paper on Insulin. He discussed the theory of diabetes, as deduced from physiological experiments up to 1922 and early experimental work leading to the isolation of insulin. Lantern slides showing the islets of Langerhans in pancreas, both normal and after the atrophy of the rest of the gland tissue, were shown, subsequent methods used for the preparation of insulin and their extension to manufacturing processes were described, with a demonstration of preparations of insulin in various stages of its manufacture. The results of insulin therapy on patients suffering from diabetes were explained, curves showing the effects on carbohydrate metabolisms exhibited, and the dangers to be anticipated and guarded against will be mentioned. The theoretical action of insulin was discussed, and deductions drawn regarding the pathological sequences in diabetes. The method by means of which bacterial fermentation in the intestines may affect normal physiological ferments of digestive glands and initiate an altered metabolism was considered, and also the relation of the same to hereditary factors, while the possibility of similar action occurring in cancer was mentioned.

CUBIC ATOMS AND BOHR'S THEORY.

W. P. Davey, in the *Journal of the Franklin Institute* for April, 1924, gives an original survey of modern atomic theory under the title of "Radiation." We quote here two passages of considerable interest, from pp. 443 and 478:—

"The most symmetrical arrangement of eight electrons is that in which the electrons occupy the corners of an imaginary cube, and in the Lewis-Langmuir picture the cubic 'shape' of the light atoms is assumed. Since the publication of these theories, the cubic 'shape' of these atoms has been verified in a rather unexpected way. The X-ray diffraction pattern of crystals of the lighter alkali halides and of the oxides and sulphides of the lighter alkali earths, show that the ions of these elements (which have the same number of electrons as the atoms of the corresponding inert gases) pack as though they were cubes with well-rounded corners. It would therefore seem reasonable to assume that the atoms of the lighter inert gases had a similar 'shape.' The theory is confirmed in the case of the heavy elements in no less striking fashion. The Lewis-Langmuir theory gives Xe eighteen electrons in each of its two outermost shells. Such an atom would approximate a sphere rather than a cube. Experimentally it is found that Cs^{+} and I^{-} (which have the same number of electrons as Xe) pack together in CsI to form a body-centred cubic structure. This structure is the closest possible packing for equal numbers of oppositely charged spheres of equal size. Furthermore, the dimensions of I^{-} determined from the crystals of its compounds show the same 'radius' in two directions about 54½ degrees apart. Such a result is inconceivable for any regular figure other than a sphere. . . . This means that, if we are willing to assume arbitrarily equation (70) [Bohr's equation, which seems capable of being interpreted so as to include Thomson's equation as given in *The Chemical News*, 1924, this vol., p. 129, which he used to account for the static atom involving a change of force from attraction to repulsion at a certain distance from the centre of the nucleus; and which he extended so as to deal with ionising potentials, photo-electric effect, and compressibilities. This equation may lead to another force law represented by an inverse cube term superposed upon it. Furthermore, by development, it contains certain features belonging to Bohr's equation for energy. The original should be consulted, as it is difficult to show accurately the possible connection of affairs], or if, some day, we can find a rational derivation for equation (70) apart from Bohr's theory, the static atom with the aid of Thomson's law of force is capable of explaining the spectra of atoms with identically the same success as the Bohr atom. Really, the difference between the two atomic pictures is largely a matter of words. The static-atom picture considers the electrons of a non-radiating atom to be either stationary (except for some sort of heat motion), or else moving about in such a way that the position assigned by the picture represents the mean position. In order that such an atom may radiate, the electron merely drops from one such equilibrium position to another closer to the nucleus, radiates its excess energy, and comes to rest at (or about) the new

equilibrium position. . . . As G. N. Lewis says, 'that state of motion which produces no physical effect whatsoever may better be called a state of rest.' We shall see later that Bohr orbits may best be considered as ellipses rather than circles. If the nucleus is one focus of an ellipse, the position given by the static-atom picture may well be the *other focus. So we see that, after all, the two pictures* of atomic structure, which at first seemed *so widely different, are really pretty much* the same, but are expressed in different words and employ a slightly different viewpoint."

See, in this connection, an account of Bieler's work, to appear shortly in *The Chemical News*; also Mr. Loring's paper on the Atom, summarised in *The Chemical News* of January 25, 1924.

NOTICES OF BOOKS.

The Electron Theory of Valency: A GENERAL DISCUSSION held by the FARADAY SOCIETY, July, 1923. Pp. 543. 10s. 6d.

In this reprint of the papers and discussions held last July at Cambridge, under the auspices of the Faraday Society, much will be found of special interest to the chemist and physicist who is delving into the problem of valency. Familiar names appear in the contributions and debates held, viz.: Sir J. J. Thomson, Prof. G. N. Lewis, R. H. Fowler, N. V. Sidgwick, W. A. Noyes, Sir Wm. Bragg, Prof. Victor Henri, C. R. Bury, Prof. T. M. Lowry, Sir Robert Robertson, Prof. Lapworth, Dr. H. Henstock, Dr. E. K. Rideal, R. G. W. Norrish, Dr. E. E. Walker, Dr. Kenner, Prof. J. F. Thorpe, Prof. I. M. Heilbron, G. N. Buckhardt, Dr. B. Flürscheim, W. E. Garner.

In a subject of this scope there is such a mass of data and *ingenious methods of* correlating it that to review a book of this nature is *extremely difficult*, and a reviewer with sufficient knowledge to pick out the wheat from the chaff without error would have to know more about the subject than any of those who took part in the discussions.

Dr. Rideal gives a summary at the end of the book, in which he refers to Dr. Henstock's opinion, which we mention here as this worker has been developing his theory in these pages, and it is our prerogative to make this selection.

This author "was of the opinion that the concept of induced ultimate polarities could be greatly simplified by the conception of nuclear tubes of force and a revolving nucleus. Although we must await the verdict of the mathematical physicist on this conception, yet important considerations have been advanced, thus the Abegg-Bodländer conception or the octet rule permits us to use both the positive and negative bonds of an atom at the *same time. Thus we can write*

```
      + H      +—Cl            H+
N≡+ H   N + —Cl   and       = N+-Cl,
      + H      +—Cl            H+
```

```
or acetic acid   CH₃-+C+-OH,
                      + +
                      - -
                       O
```

whilst a conjugated system can be expressed

```
   H+                          +H
      = C+-C-+C+- =
          -+      -+
   H+                          +H.
```

The conversion of ammonia into the *amines represents also a change of the* -*ve* valencies of nitrogen into the positive."

This book should be studied by all interested in the problem of atomic and molecular phenomena, as it contains valuable contributions to the subject.

Bibliographie de la Relativité, par MONSIEUR ET MADAME MAURICE LECAT. Pp. 338 + XI. 1924. Editeur: M. Maurice Lamertin, rue Coudenberg, 58-62, Bruxelles.

This very comprehensive compilation contains all the important and minor contributions on the theory of relativity and cognate subjects which led to the development of the theory.

Many works on mathematics, statistical tables, etc., are included. A large number of physical papers, quite apart from relativity, are indexed.

The authors are arranged alphabetically, with title of work and reference. A corresponding chronological arrangement is also given, with cross references. This section

begins with James Bradley, *Phil. Trans. Roy. Soc.*, 1728, XXXV., p. 406. It closes with 15 entries of 1924. The book is therefore up-to-date. In connection with this list there is a following supplementary one of authors, arranged alphabetically, which runs into nine pages.

A list is given of all the publications consulted, with reference numbers to the authors' list where particulars are given. It is noted that the *Encyclopædia Britannica* appears in the authors' list, but it is *not amongst the publications*, as this is doubtless treated as a book.

Extensive lists of mathematical works and papers are included in this index.

Books, pamphlets, journals, magazines and letters are included in the relativity sections. Some daily papers are included, *e.g.*, *The Times* (London).

The authors are to be congratulated on the thoroughness of the work, which is both complete and accurate.

Mathematicians will no doubt find the book of great utility, apart from the relativity part proper, owing to the classification of mathematical matter. The index will doubtless become one of standard reference. The printing is an example of neat workmanship.

A *corrigenda* is added, which makes the index more valuable by insuring its accuracy.

A Comprehensive Treatise on Inorganic and Theoretical Chemistry, Vol. IV., *Ra and Ac Families, Be, Mg, Zn, Cd., Hg*, by J. W. MELLOR, D.Sc. 232 Diagrams. Pp. X. + 1074. 1923. Messrs. Longmans, Green & Co., 39, Paternoster Row, London, E.C.4. 63s. net.

In this large volume of the series, equal to the others in size, we find a wealth of material, as may be judged by the main headings: The structure of matter; radium and radio-activity; the architecture of the atom; beryllium or glucinium; magnesium; zinc and cadmium; mercury.

The author follows his previous practice of heading sections with apt quotations. The system of treatment leaves nothing to be desired, for by means of sub-headings and heavy-faced type the subject matter indexes itself as one proceeds, and to be particularly commended is the heavy type, which makes it easy to find the material required by simply turning over the pages in the section selected. There is in addition an index. The references are so numerous that even to count them would be a task. However the author managed to get together in such an orderly way the huge array of material is almost beyond comprehension. On this account it would be most unfair to pick out here and there flaws in the text; but it must be remembered that the time taken to deal with the material has in a few cases led to citations of early views, especially in those cases where the advances have been very rapid, as in the case of the first part dealing with atomic physics.

The survey of atomic physics is comprehensive, and considering the literature consulted and the references given (including many minor contributions) this part of the book is made both interesting and valuable as an index.

The book is singularly up-to-date in some topical matters of fundamental interest. For example, the section dealing with the "radiation theory of chemical action" contains about 2,000 words, not counting references.

In order to give the reader some conception of this work, the author deals with the unity of matter; the whole-number atomic weights; spectrum analysis; ionising potentials; Zeeman effect; Stark effect; Lockyer's evolution hypothesis; cathode rays; Rontgen rays; X-rays; K and L radiations; Moseley's law; photo-electric effect; positive-rays and isotopes; radio-activity; intra-atomic energy; artificial radio-activity; mass and matter (this part needs amendment); Rutherford atom; Bohr atom (diagrams on pp. 169 and 170 are seemingly accurate according to one theory but wrong according to another); periodic law; normal and contra-valencies; intra-molecular ionisation; Langmuir's theory and Lewis' cubical atoms; &c.

The displacement law on page 129 requires supplementation in view of developments following Russell's statement of the law in an imperfect form in *The Chemical News*, 1913, CVII., 49.

There are a number of statements which, though historically true, should be revised in their presentation, at least so it would seem. The statement on page 56 that the radio-activity of ordinary elements cannot be detected because of the low velocities of

the emitted particles is not to-day an accepted view. It is only fair to state that the converse view, now accepted, is previously given; but space is taken up with statements bordering on the above kind, and this practice leaves the reader too much in doubt about matters which have been cleared up to the point of general acceptance and need not be weakened by subsidiary views. In this criticism, however, we feel that we are in the wrong, partly at least, for the author gives a historical survey, and it is in this respect the book is of great value. The work is essentially one of reference and not one which gives the cleared-up and well-fixed knowledge so dear to many. Science is humanely alive, so to speak, and the author makes it apparent in his treatment.

The parts dealing with elements: Be, Mg, Zn, Cd, Hg, are very complete both from a purely chemical and physical point of view. The treatise is, in short, a mine of information, and the complete set of volumes will form a standard work of historical reference.

The publishers deserve special mention for the excellence of the printing, and we await with interest the next volume.

New Patents.

This list is specially compiled for *The Chemical News* by Messrs. Rayner & Co., Registered Patent Agents, of 5, Chancery Lane, London, from whom all information relating to Patents, Trade Marks, and Designs can be obtained gratuitously.

Abstract Published Last Week.

211720—Dyeing cellulose acetate.—British Dyestuffs Corporation, Ltd., 70, Spring Gardens, and Baddiley, J., and Shepherdson, A., Crumpsall Vale Works, Blackley, both in Manchester.

Basic dyes, dyeing with:—Cellulose acetate silk, or fabric containing it, is dyed by means of aminoanthraquinones. The aminoanthraquinone is used in the dye-bath in a fine suspension or in colloidal solution. Thus the amino compound may be merely suspended in the dye-bath with or without addition of an emulsifying agent such as soap or Turkey-red oil, or the amino compound may be brought into colloidal solution by mechanical disintegration, or by solution in some solvent miscible with water, the solution being then poured into the dye-bath; an emulsifying agent or protective colloid, such as a sulphonated oil, may be used as the solvent or added to the dye-bath. The following products are specified as suitable:—1-aminoanthraquinone, 1-amino-2-methylanthraquinone, 1-methylaminoanthraquinone, 1 : 4- or 1 : 5- diaminoanthraquinone, 1-amino-4-oxyanthraquinone, diaminoanthrarufin, and diaminoanthrarufin methylated in one or both amino groups; these dye acetyl silk yellow, yellow-orange, red, violet, red, crimson, blue, and sky-blue shades respectively.

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[Further Lists of Important Works will be advertised next week.]

THE CHEMICAL NEWS,

VOL. CXXVIII. No. 3344.

British Empire Exhibition.

Designed to present the whole story of the Empire to-day, the Exhibition consists of exhibits completely representative of each of the Empire's various components. The largest pavilions are those of Australia, Canada, India, South Africa and New Zealand. Other special buildings erected for the purpose, contain exhibits from East and West Africa, West Indies, Burma, Ceylon, Cyprus, Hong Kong, Newfoundland, Malaya, Malta, Palestine, Bermuda and Fiji.

The General Engineering Section, which includes shipbuilding, marine and mechanical engineering, consists of exhibits representing 300 leading firms of Great Britain. This section contains machines ranging from 150 tons to the most delicate testing instruments ever made. The electrical engineering section includes every branch of the industry represented by over 200 firms.

The Palace of Industry is devoted to displays of all industries which do not come under the general heading of "Engineering."

The Chemical Section, heavy and fine, and the allied industries, soap, perfumery, paints, etc., occupies some 40,000 square feet.

About 100 of the leading firms interested in every branch of the industry have combined to organise a comprehensive display of material and products.

The gas exhibit occupies a space of 12,500 square feet. Building and heating industries fill 14,867 square feet. Paper, stationery and allied trades, 11,250 square feet. The domestic and industrial applications of coal-gas are shown in various ways. Its extended use should follow the demonstrations of its many uses and possibilities. The chemical products obtained by the carbonisation of coal are well represented and displayed in the Chemical Section.

The range of machinery, making chocolates, confectionery, etc., stretches more than a tenth of a mile. Leather and boots cover 10,000 square feet with representative exhibits. Pottery and glass fill 12,812 square feet, and rubber manufactures will occupy over 7,000 square feet.

A colliery has been erected in the grounds, and extends for a quarter of a mile. Methods of coal production are to be seen.

Among the Canadian exhibits will be a nugget of silver, weighing 2½ tons, the biggest ever unearthed.

India's beautiful pavilion, with its graceful dome and towering minarets, touches a note of Oriental splendour.

Here will be displayed India's metal work, her carpets, curtains, and silks, and her wonderful carving in wood and ivory.

BRITISH DRUG HOUSES, LTD.

INSULIN.

The discovery of insulin constitutes one of the greatest romances of science. No other chapter in the history of medical progress, perhaps, records more painstaking research and indefatigable labour than that which led up to the discovery of insulin. Experiments having been carried out which proved that the disease of *diabetes mellitus* is caused by degeneration of certain tissue in the pancreas known as "Islets of Langerhans," with resulting deficiency of their internal secretion, many attempts were made to isolate the active principle concerned with the object of utilising it in the treatment of diabetes. Finally, in 1922, a successful preparation containing these active principles was obtained by Drs. Banting and Best, working in the laboratories of the University of Toronto. The preparation having been discovered, a process was afterwards devised for preparing the substance on a scale large enough for practical purposes. This process, originated by Banting and Collip, resulted in the preparation insulin, the active principle extracted from the normal pancreas, being introduced to the medical world.

The manufacture of insulin was undertaken by The British Drug Houses, Ltd., in association for this purpose with Messrs. Allen and Hanburys, Ltd., of Bethnal Green, London, in the beginning of 1928, under licence granted to the two firms by the Medical Research Council. The Canadian discoverers had previously

granted a patent for the manufacture of insulin to an American firm, who had thus obtained a six months' start over the British manufacturers. The B.D.H. erected new buildings and devised and installed special plant. Working at high pressure, work being continuous day and night and throughout week-ends, the staff of highly skilled workers specially trained for this purpose, ably backed by the firm's staff of skilled engineers, quickly overcame the exceedingly great technical difficulties incidental to the manufacture of this fugitive substance; and in an incredibly short space of time, namely, less than three months, the B.D.H. achieved the production of insulin on the large industrial scale and succeeded in placing insulin on the market.

The original process for the manufacture of insulin communicated from Toronto has been modified by the B.D.H. by the introduction of several improvements due to their own researches and unique experience gained in the manufacture and purification of this product on the large scale. The B.D.H. product is known as "A.B." Brand Insulin. It is of full and guaranteed activity, and is highly purified, stable and sterile. Experiments have been carried out which prove that "A.B." insulin retains its full activity even in tropical climates, this stability being due to the special process of purification which the insulin undergoes in the course of its manufacture.

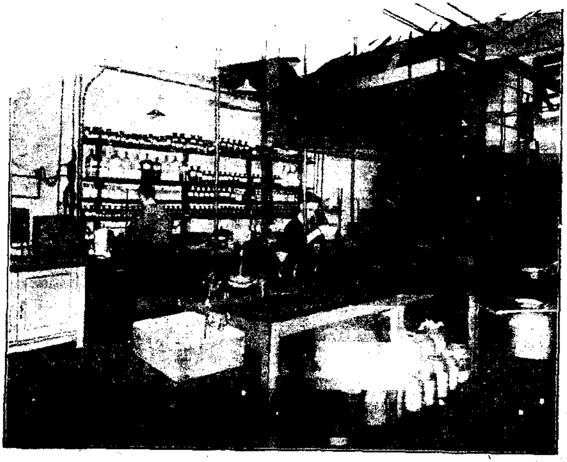
As announced recently, there has been a considerable reduction in the price of insulin.

INDICATORS.

In this class, the British Drug Houses exhibit affords striking evidence of the *pioneer work which has been done by this* firm in the production of the newer indicators used for the determination of P_h value. The number of these synthetic organic colouring matters manufactured by *this firm has been greatly increased,* and indicators ranging from P_h—0.3 to 14 are now available

The exhibit of indicators consists of a variety of dyestuffs of the Phthalein, Sulphone-Phthalein, and *Azo groups, among* which the following examples may be mentioned:

Bromo-phenol blue, Dimethyl-amino-azobenzene, Lacmoid, Methyl-orange, Methyl-red, α-Naphthol-phthalein, α-Naphthol-sulphone-phthalein, Phenol-tetrachlor-phthalein, Phenol thymol phthalien, Thymol blue.



B.D.H. Universal Indicator is the most useful reagent for determining quickly the approximate P_h of a fluid. The Universal Indicator is a mixture of several indicators and shows the whole range of spectrum colours from red to violet in the correct order. It is used by adding 0.1 cc. of the indicator to 10 cc. of the liquid under examination, when the colour produced will indicate the approximate P_h. It is particularly valuable for the control of manufacturing operations.

AIR PURIFICATION—OZONE.

In the Building Section the Ozonair Apparatus for air purification, ventilation, laboratory use, etc., is exhibited. In addition to this, at the request of the Government, this firm show a working plant for water sterilisation. This exhibit is housed in the section devoted to tropical hygiene in the annexe adjoining the Government Pavilion.

CAMBRIDGE INSTRUMENTS AT THE BRITISH EMPIRE EXHIBITION.

In addition to the large and representative selection of instruments found on their stand in the Palace of Engineering, various Cambridge temperature measuring and engineering instruments are to be seen in operation in the model power station, while similar or other instruments manufactured by the firm are shown in connection with many other exhibits, such as, for example, those arranged by the British, Australian and New Zealand Governments respectively. The Cambridge and Paul Company's exhibit comprises electrical CO_2 and CO apparatus, combined electrical CO_2 and temperature indicators and recorders, dial draught and pressure gauges, draught and pressure recorders, pressure and vacuum recorders, indicating and recording thermometers of the mercury-in-steel type, thermo-electric, resistance, radiation and optical pyrometers, stator and rotor temperature outfits, pyrometer testers and potentiometers, stress recorder, micro indicators, fuel calorimeters, electrical instruments for A.C. and D.C. measurements, and other precision instruments.

In the Model Milk Depot, the National Federation of Master Dairymen's Association are utilising eleven Cambridge totally enclosed thermographs, two of which are double instruments giving two records on one chart, for recording milk-pasteurising and cooling, bottle-washing, steam and brine temperatures.

The Royal Society exhibit in the British Government Pavilion also includes a representative selection of Cambridge physical, physiological and biological instruments, including an electro-cardiograph for taking heart records, a recording clinical thermometer outfit, an instrument for measuring the percentage of CO_2 in alveolar air, ray track apparatus, enabling the continuous emission of ionising particles to be observed and photographed, and various other physiological and geophysical instruments. The exhibit of the National Physical Laboratory in the Palace of Engineering includes a Cambridge thermo-electric recorder, measuring furnace temperatures.

It will be seen that Cambridge instruments are shown applied to practically every branch of industry, and the visitor to the Exhibition who is interested in the application of scientific instruments to industrial problems, cannot fail to be impressed by the large and varied field covered by the products of this well-known company.

DYESTUFFS AND INTERMEDIATES.

One of the greatest industrial advances which have been made in modern times is the ending of the dependence of British users of dyestuffs on outside sources of supply. One of the many firms who have concentrated with success on this end is Messrs. Hickson and Partners, Ltd., Ings Lane, Castleford.

The chief aim of this company has been to make their works' processes self-contained. With this view, the present programme of the firm is that the only raw materials purchased are nitrate of soda, crude benzol and sulphur either in its crude form or in the form of pyrites.

From these elementary raw materials, acids, as well as spirits such as benzene, are made. The firm specialise in the sale of high quality motor benzol, which is produced at Castleford, entirely from English raw materials. From this secondary stage, the products go through many intermediate stages in the manufacture until the final dyestuffs are obtained.

In most cases, Hickson and Partners, Ltd., sell their intermediates to other dye-stuff-making concerns, who carry out the final stage in the production of the dye-stuffs themselves. The company do, however, turn out a few finished dyestuffs in their own works, and it is interesting to see the many intricate stages through which the materials pass from the crude benzol before the finished dyestuffs are obtained.

This firm make a great speciality of the vital intermediate product, aniline, which, as will be very generally appreciated, is the most essential intermediate product in the aniline dyestuff trade. Of the dye-stuffs turned out by the company, two important ones are magenta and sulphur black. The former was one of the first known aniline dyes, and is to-day a product which is still very widely used. Sulphur black is the most important colour used for the dyeing of cotton, and immense quantities of this are used every year.

The firm have secured the British patent rights of M. Vidal's latest sulphur blacks. After unavoidable delays in erection of suitable plant for these new processes, these blacks are now turned out and marketed for the home user in liquid form, ready for use, under the title of "Vidal Victory Black Liquid," which dyes cotton without any further addition of sulphide. Various types ranging from a green shade of black almost identical with aniline black to a heavy red shade black are made. These products are also turned out along with ordinary sulphur blacks in powder form.

A reduction plant for the manufacture of monamines is the next sequence, and this unit is at present working at full output, turning out aniline, toluidines, etc. Hickson and Partners have devoted much time and experiment to the attainment of the highest possible degree of purity. Distillation units have been erected both for fractionating and direct distillation under vacuum, and the purity of the nitro and amido products now manufactured is claimed to be equal to that of the best German articles.

Various types of magenta crystals and powder are sold under the original British name for this product, namely, "Roseine." Special attention has been devoted to the production of pure Para Rosaniline Base for the manufacture of the finest shades of ink blues. soluble and alkali blues. Other quality Rosaniline bases of excellent purity are made for the medium and redder shades of blues.

The firm attach great importance to their research department, which is devoted exclusively to their future programme. They realise that this is a vital factor as regards their future welfare. Excellent results have already been obtained, and it is hoped that, with revival of trade, a plant for the production of benzidine, tolidine, dianisdine, etc., will shortly be in operation.

NOTES ON THE EXHIBITS SHOWN IN THE SCIENTIFIC SECTION OF THE CHEMICAL HALL AT THE BRITISH EMPIRE EXHIBITION (1924).

Photographic Section.

British Photographic Research Association.

Four mounted exhibits, each occupying about 30 in. x 22 in.

1.—Prints showing that when a grain in the photographic plate becomes developable by exposure to light, its developability is not communicated to contiguous grains.

Prints showing the sensitive centres on silver bromide grains at which the process of development starts.

2.—Plates and prints proving that light action may be imitated by submitting photographic plates to the action of chemical agents in the absence of actinic light.

3.—Prints illustrating the crossed-wedge method of determining the Hurter and Driffield curves of photographic emulsions by means of which their characteristics can be rapidly ascertained. Photomicrographs of the emulsions in question.

4.—Bromide prints toned with pure colloidal sulphur.

W. F. A. Ermen, Esq.

Two mounted exhibits, each occupying about 30 in. x 22 in.

1.—A print developed to black and whit with dimethyl paraphenylenediamine only A second print developed with the sam developer, except that α-naphthol or chloro α-naphthol has been added.

2.—A print similar to the second one i (1), but from which the silver has been re moved, leaving only the indophenol image Mr. Ermen also wishes to show about 1 lantern slides to illustrate the various colou

differences obtained with the above processes.

A. J. Bull, Esq., of the London County Council School of Photo-Engraving and Lithography.

Five mounted exhibits, each occupying about 30 in. x 22 in. These consist largely of reproduction specimens accompanied by curves, illustrating the latest work on the rendering of gradation, etc.

Professor J. W. Hinchley.

An exhibit illustrating the July system of colour photography. The exhibit would occupy a wall space pf about 2 ft. x 1 ft. It is suggeste dthat it takes the form of a wall-case, provided with a blind to prevent fading. The prevention of fading is very necessary, since the slides are unique and cannot be replaced.

D. E. Benson, Esq., Southport.

An exhibit dealing with Raydex colour prints and the photographic problems connected therewith. A space of about 2 ft. x 3 ft. would be required.

J. Dudley Johnston, Esq., President of the Royal Photographic Society.

A selection of about 100 lantern slides, illustrating the various tones which can be obtained by development.

This is the only exhibit requiring bench space.

T. Thorne Baker and Mr. Davidson.

Two mounted exhibits, each occupying about 30 in. x 22 in.

1.—Sets of photo-micrographs of developed grains, showing effects of different developers and varying conditions of development on their size and formation.

2.—Ultra-violet spectrograms showing the influence of inductance on the intensity value of the spark used as an illuminant or light source for therapy treatment.

J. Willis Grundy, Esq., Barnet.

1.—Photographs of sensitive grains, 12 in. x 7 in. and 8 in. x 8 in.

2.—Characteristic curves of various dry plates, 12 in. x 10 in.

3.—Aerial photographs, 26 in. x 11in., 10 in. x 8½ in., 12½ in. x 8 in.

Messrs. Storr and Bloch, of Ilford.

A series of spectrograms, illustrating the variation possible in the spectro-sensitiveness of emulsions treated with various dyes. Space occupied: about 2 ft. x 2 ft.

The total wall space required for the above exhibits is of the order of 80 sq. ft. This space, however, does not allow for that required for the proper hanging.

Exhibits Showing Progress in Explosives, Research and Manufacture, 1900-1924.

Sir Robert Robertson, K.B.E., F.R.S.

The subjects included in this exhibit are arranged in the order of their description in "Chemistry in the 20th Century," and are shown in this catalogue in italics.

1900-1914 Manufacture. — In 1900 the manufacture of nitroglycerine and nitrocellulose was well established, and gelatinous explosives were used in trade (blasting gelatine) and for propellants (cordite and ballistite). The first practical smokeless powder had been made by partially gelatinising nitrocellulose brought out in 1882 as the *E.C. Sporting Powder,** by Mr. Walter F. Reid.

Three scale models made by Messrs. Fraser, illustrate improvements in manufacture introduced about the beginning of this period at the Royal Gunpowder Factory. By the Thomson *displacement process for making gun-cotton*, the waste acids in contact with the nitrocellulose which they have produced are removed by downward displacement by a layer of water; in this way the mechanical handling of fuming acid material, formerly in use, is avoided and a purer product obtained with the employment of less labour. The model shows the displacement nitrating pans in groups of four, with their inlet and outlet connections for acids.

The displacement process for making nitroglycerine of Nathan, Thomson and Rintoul is shown in the model in which the protecting mounds for the houses are partially cut away. The principle of the process is to introduce into the bottom of the nitrating vessel after a charge of glycerine has been nitrated, waste acids from a previous charge, so that the layer of nitroglycerine which swims up to the top is run off into a vessel in which it is washed. The houses in which it undergoes its final washing and filtering, and in which all solutions

contaminated with nitroglycerine are collected, are shown, as well as their connections. The process led to increased safety and economy in manufacture, and height was saved in erection of a factory.

The model of an *acetone recovery factory* shows the process of Robertson and Rintoul for extracting acetone existing in the state of vapour in air, and recovering it for use again as a gelatinising solvent in the manufacture of cordite. The acetone is evaporated from the cordite in drying stoves, and exists in the air of these stoves in small concentration. The model shows how this air is drawn upwards through towers down which strands of coir fibre carry in a zig-zag fashion a solution of sodium bisulphite. The acetone is then absorbed by this solution, which gives it up in an impure air form on being heated in a primary still; the effluent goes back into circuit. The acetone is finally delivered pure from a rectifying still. The apparatus has no back pressure, and can be used for purifying air or gases for other purposes.

1900-1914 Research.

Decomposition and stability of explosives.—For storage purposes, it is necessary to determine the rate of decomposition of explosives at different temperature. Robertson's *apparatus* for following *the decomposition of nitroglycerine* by the spectroscopic estimation of the nitric peroxide evolved is shown. As nitroglycerine is volatile, the spirals are arranged so as to be used alternately as preheaters of the CO_2 stream or condensers of nitroglycerine. The temperature coefficient of the decomposition of nitroglycerine throughout a long range was determined.

Farmer's apparatus for determining the *stability of high explosives* in an evacuated vessel by means of mercury manometer is shown. By working at different temperatures, it gives information enabling stability at warm storage temperatures to be ascertained. A diagram illustrates the various *modes of decomposition* that *nitrocellulose* may undergo (Farmer).

Calorimetry and Pressure of Propellants.

Calorimetric apparatus is shown by which MacNab and Leighton determined the *heat values and gases* evolved from shot-gun propellants, and estimated the relative temperature of explosion; also the calorimetric bomb used by Robertson for determining the effect of the non-explosive constituents on the calorimetric constants of cordite. An example, with diagram and description, is given of Petavel's *recording manometer* for registering by an optical device the rise and fall of pressure in a closed vessel in which a propellant is fired.

Methods of Nitration.

A safe method of nitration of dimethylaniline to *tetryl*, a violent explosive used as an intermediate between the detonator and a more inert main charge of explosive, was worked out at the Research Department, Woolwich, and transferred to manufacture at the R.G.P.F. before the war. Other methods have been investigated for obtaining this body, such as those described on the diagram of Nobel's. The difficulty of introducing four nitro-groups into the benzene ring was overcome by Flurscheim, who prepared *tetranitroaniline*, a powerful explosive used in some other countries; a diagram gives its derivation and shows the formation of other bodies from it.

1914-1924 Manufacture.

This includes the war period, during which, at one stage, there was a weekly production of: 2,000 tons of cordite, 1,500 tons of trinitrotoluene, 3,000 tons of ammonium nitrate, 300 tons of picric acid, and 200,000 tons of nitric acid and of sulphuric acid.

As the supply of acetone, the gelatinising solvent for cordite failed, a new propellant (*cordite R.D.B.*) was brought out by the Research Department, Woolwich, in which that solvent was replaced by ether-alcohol and the ingredients altered in an appropriate manner so as to obtain the same heat energy and ballisities from the propellant; no essential change in the technique of manufacture was made. Cordite R.D.B. became ultimately the sole propellant for the Land Service.

A wall case contains specimens of the raw materials and intermediate products for the *manufacture of propellants.*

For the manufacture of trinitrotoluene, a process with several novel features was evolved at the R.D., Woolwich, before the end of 1914, and demonstrated in a *quarter ton experimental plant.* This process was used in the T.N.T. factories of Oldbury and Queen's Ferry, erected by Mr. K. B. Quinan. A *photograph* of the small scale plant which exemplified the advantage of experimenting on an intermediate stage between laboratory process and production on the large scale is shown; one of the ex-

hibits is a *block of T.N.T.*, showing the "piping" which may occur on casting it.

To conserve the supply of T.N.T. a mixture of T.N.T. and ammonium nitrate was worked out as a high explosive early in 1915 in the R.D., Woolwich, and its properties determined; the name of *Amatol* was given to it. The ammonium nitrate is not a diluent merely, but is in itself an explosive; it contributes to the mixture oxygen which it has in excess, while T.N.T. is deficient in this respect. Amatol was ultimately the sole high explosive for the Land Service, 4,000 tons a week being made, and it was adopted by the United States. Models are shown of the *volume of gases produced on detonation* of a small sphere of amatol, and the *fragments of an 18-pdr. shell* which was burst by the detonation of amatol are arranged on a board.

A wall-case contains examples of the raw materials and intermediate products for the *manufacture of high explosives*, and their relationship is indicated by a system of arrows.

A collection of the *records* of the technical working of the explosives factories has been prepared by Mr. W. MacNab and published by the Stationery Office. These studies are useful not merely to the specialist in explosives, but also to the teacher and general technologist.

1914-1924 Research.

Viscosimetry.—In connection with the manufacture of Cordite R.D.B., the work on the viscosity of cuprammonium solutions of cellulose and of ether-alcohol and acetone solutions nitrocellulose, became urgent, and this was carried out in the *falling sphere viscosimeter* by Gibson, Masson, and their assistants at the R.D., Woolwich. Information was thus gained on the effect of content of nitrogen, on the significance of the point of lowest viscosity, and led to some general theoretical conclusions on viscosity. *Diagrams* of work done at Messrs. Nobel's Research Department and shown, giving relationship between the log of viscosity and concentration of Nobel's (1) cellulose, (2) ammonia, and (3) copper in the solution.

Organic and Physical Chemistry of T.N.T.—The products of nitration of toluene were exhaustively investigated by Brady, and their thermal analysis by Gibson, at the R.D., Woolwich. A diagram showing the *derivation* of the nitrotoluenes by direct nitration and also indirectly is shown, as is also a *space model* from which the proportions of the isomerides of T.N.T. in a mixture can be deduced. The quantity of these isomerides in T.N.T. for many Service purposes had to be diminished, as they led to the formation of liquid matter which found its way into different mechanisms such as shell-fuses.

Calorimetry.—*The heats of nitration* of the different nitrotoluenes as determined by Garner are shown on a diagram. The *calorimetric bomb for high explosives*, specially adapted for withstanding high pressures and used by Robertson and Garner for determining the heat of detonation and gases evolved when high explosives are truly detonated in strong envelopes, is exhibited.

Sensitiveness of explosives.—To determine this without leaving the interpretation of personal conjecture, the *apparatus* shown by a diagram has been devised by Rotter, the completeness of the explosion of the material on an anvil, struck by a *drift working in a closed vessel*, being indicated by the volume of gas evolved as shown by a manometer.

Pressure developed by explosives.—An important development in determining the pressure given by explosives when they detonate was the application of the principle of *Hopkinson's pressure bar* by Quinney, at R.D., Woolwich. One of the early types is shown. An explosive is detonated at one end of a steel bar, when a short length attached by air suction or grease to the other end of the bar flies off and is caught in a ballistic pendulum which measures its momentum. As the time of passage of the impulse in steel is known, the second factor in the momentum, the pressure, can be calculated. This gives for a ½ in. length the mean maximum pressure over 1/200,000th of a second, and this, for high explosives, is about 300 tons to the square inch. This instrument was fruitful in differentiating between explosives as to their violence, in advancing the theory of detonation, and in facilitating the design of mechanisms containing explosives. It is now being used also by Messrs. Nobel's in the investigation of the properties of trade blasting explosives.

Diagrams lent by Research Department, Woolwich, and Messrs. Nobel's are shown, illustrating the proportion of momentum trapped by end-pieces of different lengths, the effect of air-gap between the explosive

and the bar, the forms of the detonation wave in the bar, the relative pressures developed by a series of typical explosives, including the effect of the addition of ammonium nitrate to trinitrotoluene.

Rate of Detonation. — Diagrams are shown illustrative of a method by Wagstaff of determining the rate of detonation of an explosive, by measuring the rate of discharge of an electrical condenser. The breaking of the first wire embedded in the explosive permits of the discharge of the condenser, through the second, while the breaking of the second wire by the detonative wave leaves only a small residual charge. From the quantity of the charge which disappears between the two breaks, and the known law of rate of discharge, the time taken for the detonation to proceed between the two wires can be calculated.

Thanks are due to the following bodies, who have kindly lent exhibits: The Board of Trade, the Imperial War Museum, the Science Museum, the Research Department, Woolwich, and Messrs. Nobel's Explosives, Ltd.

Professor W. L. Bragg.

Models of Crystal Structure.

The models illustrate the crystalline structures of elements and inorganic compounds. In crystals, the atoms are arranged in a regular pattern, and these patterns have been analysed by illuminating the crystals with X-rays and observing their effect on the rays.

The models are made to an exact scale of one hundred million to one. The positions of the atoms in the crystals relatively to one another, and the symmetry of the patterns which they form, are shown by the balls, each representing an atom, of which the models are made. The signs of the balls indicate approximately the regions occupied by the electronic systems of the atoms.

The models represent crystals of the elements, such as carbon, arsenic, selenium, and the metals; also of compounds such as common salt, zinc-blende, iron pyrites, calcite and aragonite, and aluminium oxide. A more complete description of the interesting features in these structures is given with each exhibit.

Professor A. Smithells, C.M.G., B.Sc.,

appearance of the four constituents of an ordinary coal will readily recognise the fusian, durain, clarain, vitrain in their own coal scuttles after inspection of the samples exhibited. Powdery fusain, hard dull durain, bright clarain, and brilliantly shiny vitrain are easily distinguished by eye, once attention has been called to them. Photographs of the micro-structure of the four constituents, and exhibits of the various types of coke which they provide, are supplemented with charts showing how the composition of coal determines its utility for various purposes.

The causes of spontaneous inflammation of coal in the pit are illustrated by charts; interesting, historically, is the exhibit of the first apparatus used to prove the explosive nature of coal dust in air.

The removal of objectionable sulphur compounds from coal-gas is shown in a laboratory apparatus, and a model of a large scale plant for the same purpose is exhibited.

Flame.

Photographs show the mode of travel of flame in explosive gas mixtures. Apparatus used for investigating the conditions of ignition of gases is exhibited, together with charts illustrating the results obtained. Other apparatus shows how the two cones of a non-luminous flame were first separated. There is also an exhibit of the device used for the flameless combustion of gases, the object of which is to improve the efficiency of gas heating.

Sir Ernest Rutherford, F.R.S.

List of Exhibits by the Cavendish Laboratory, Cambridge.

Some aspects of radio-activity and their bearing on atomic structure:

(a) The nature of the alpha particle.

(1) Diagram of the original apparatus for determining the velocity of alpha particles.

(2) Diagram of the apparatus used to measure the charge carried by an alpha particle.

(3) Diagram of the apparatus used for the production of helium by accumulation of alpha particles.

(b) The counting of alpha particles.

(1) Diagram of the electrical counter of Rutherford and Geiger.

(2) Photograph trace of alpha particle (enlarged).

(c) Beta and gamma rays from radio-

(1) Diagram of apparatus used by Rutherford and Robinson to obtain beta-ray spectrum of radium B.
(2) Data card and two photographs.
(3) Diagram and photograph of apparatus of Rutherford and Andrade used to measure the wave of length of gamma rays from radium B.
(d) Work of Moseley on Atomic Numbers. Photograph of X-ray spectra of some of the elements.

Exhibit by Mr. C. T. R. Wilson, F.R.S.

The scattering of alpha particles. Complete exhibit of six photographs, each 20 in. 15 in., mounted.

Exhibit by Dr. F. W. Aston, F.R.S.

sotopes.

1.—Photographs of typical mass spectra, 6 in. x 12 in.
2.—Diagram showing principle of the nass spectrograph.
3.—Photograph, positive ray parabolas f Neon.

Dr. W. R. Ormandy, F.I.C., F.C.S.

The exhibit consists of—

1.—Twenty bottles exhibiting various tages in the conversion of cellulose into ugar by two modifications of the acid hyrolysis process.
2.—An exhibit of phenol and cresol conensates at various stages with various conensing agents from Synthite, Limited, Vest Bromwich.
3.—Ditto from Damard Lacquer Co., Birmingham.
4.—Small exhibit from Erinoid Co., of troud, showing products produced from asein converted into a plastic mass by ressure and stabilised by formaldehyde.
5.—Original apparatus used by Mr. ckermann for his work on the pressure of uidity.
6.—Twyman's instrument for testing the nnealing of glass.

Professor F. C. Thompson.

The outstanding features of the exhibit y the Metallurgical Department of the niversity of Manchester and W. E. W. illington, Esq., M.Inst.C.E., M.I.Mech.-., are the models and illustrations dealing ith the effect of working both hot and cold n the crystalline structure of metals. The echanism of plastic deformation is reealed, and some of its bearings suggested. In particular an explanation of the "fatigue" of metals is offered.

Other exhibits include samples of metallic ingots illustrating the crystallisation of metals and the effect of the casting temperature on this. Photomicrographs of the structure of metals and alloys are included.

Professor Hinchley.

Chemical Engineering.

Two model evaporators.
Model of phosphate den.
Premier mill.
Cast iron mixing digestion half-gal.
Cast iron mixing digestion one-gal.
Photographs.
Model of pump.
Centrifugal machine.
Six ball bearings.
Set of stoneware models of chemical plant.

Professor J. T. Hewitt.

Coluring Matters.

The most interesting exhibit will be that of original specimens of artificial dyestuffs prepared by the late Sir William Perkin and skeins dyed with original mauve. Further, Professor A. G. Perkin is showing specimens illustrating his researches on the constitution of natural dyestuffs. The exhibits will also include those from Professor Heilbron, Dr. Everest, Dr. Silberrad, British Dyestuffs Corporation, and Messrs. L. B. Holliday and Co., Ltd.

Dr. Everest is exhibiting a very interesting collection of plant pigments, the so-called anthocyanidins which he has himself extracted from flowers, and the constitutions of which have been determined. In addition, the dyeing properties of these is well exhibited on specimens of silk skeins. Professor Hewitt's personal exhibit comprises some sixty specimens of styryl pyrylium salts, which are closely related to the flower pigments themselves. The wonderful colour of these in solution is also being shown.

Professor G. G. Henderson.

Terpenes.

Among the most interesting are those sent by Professor W. H. Perkin, which illustrate the synthesis of Limonene, the first of the naturally occurring terpenes to be prepared by synthetic methods, and of epicamphor, the interesting isomeride of

ordinary camphor. Professor Henderson is also showing specimens illustrating the synthesis of some of the few terpenes which have been prepared by synthetic methods.

Dr. T. P. Hilditch.

Catalysis Section.

The outstanding features which will appeal to the ordinary visitor are the scale model plant for the oxidation of ammonia (by the United Alkali Co., Ltd.), which is extraordinarily well done, and the various types of hardened oils which are displayed in moulded blocks (J. Crosfield & Sons, *Ltd.*).

Visitors with any knowledge of chemistry will, in addition, be interested in the full-size converter unit of the United Alkali Company's process for oxidising ammonia to nitric acid, and in the various catalytic processes which serve for the interconversion of alcohol, acetaldehyde, acetic acid, and their related derivatives.

PARTICULARS OF EXHIBITS.

(Continued from Page 296.)

The Midland Tar Distillers, Ltd.

This exhibit, by the Midland Tar Distillers, Ltd., in co-operation with the South-Western Tar Distilleries and Messrs. Burt, Boulton & Haywood, Ltd., consists of samples of primary and intermediate products obtained by the distillation of coal tar.

The works of the first-mentioned firm (nine in number) are distributed over the Midlands of England, those of the South-Western Tar Distilleries (five in number) being spread along the South Coast; Messrs. Burt, Boulton & Haywood's activities are wider reaching, as, in addition to their English works (four in number), which are leased respectively to:—

The Prince Regent's Tar Distilleries (London Works),

South Wales Tar Distilleries (South Wales—two works),

South-Western Tar Distilleries (Southampton Works),

for the distillation of tar under a profit-sharing scheme with the gas undertakings which produce it, they also operate in Belgium, France and Spain, and have in...ts in Canada. They were among the pioneers of tar distillation both in this country and on the Continent.

It is worth noting that most of the tar distilled by the Midland Tar Distillers, Ltd., and the South-Western Tar Distilleries, is worked under a profit-sharing scheme similar to the one referred to above. The schemes are all administered by committees representing the gas undertakings and the respective distillers.

The exhibit illustrates the wide ramifications of the industry, even in its earlier stages, the many compounds produced for the treatment of roads being particularly *noticeable. Specimen sections of roads,* after many years' use, originally treated with the compounds exhibited, are shown.

Samples of horticultural specialities, disinfectants, tanning materials, medicinal compounds, etc., are also included.

Models of two types of plant for the continuous distillation of coal tar are exhibited by the Midland Tar Distillers, Ltd. (Major's Patent) and Messrs. Burt, Boulton & Haywood, Ltd., respectively, together with a model creosoting plant by the latter firm.

An exhibit by Synthite, Ltd., at this stand, illustrates a further stage in the coal tar industry. The various useful and ornamental articles exhibited are manufactured from "Synthite" (a condensation product of phenol). The uses to which this material can be put are practically unlimited.

"Synthite," Ltd., are the largest British manufacturers of "Formaldehyde," and samples of their products are shown.

The South Metropolitan Gas Company.

The stand has been designed and built by the company to display to advantage Metro chemical products obtained in the distillation of coal. The benzene ring, so much used in the formulæ of coal tar chemistry, is applied in many ways to the structure of the exhibit for decorative purposes, and is the means of assisting largely in the display. Most prominence is given to the well-known Metro sulphate of ammonia, which is presented in bulk in terrace-garden-like surroundings. Parts of the balustrade woodwork used in the framing of the sulphate scheme have been treated with Metro creosote, which demonstrates the series of brown shades offered by the manufacturers. Metro disinfectant fluid, road tar to the specification of the Ministry of Transport, benzol and pitch, also occupy important positions on the stand.

A strong feature is the gas lighting arrangements by Metro appliances arranged above samples of solid smokeless fuels held in braziers surmounting four octagonal cabinets. Each cabinet bears Metro products allied to each other in the processes of manufacture. Intermediates for dyes, ammonia, coal tar and inorganic products, and heavy inorganic acid.

Among the Metro chemical specialities are:—

Dry Neutral Sulphate of Ammonia.—The best harvest is to be obtained by the use of Metro sulphate, which is specially prepared to enable the farmer to broadcast the richest form of nitrogen evenly and easily on the land for bumper crop production. Being acid-free, it retains its dry, crystalline form over long periods of storage. Its powerful fertilising properties are secure from the day of its manufacture. The sacks in which it is transported and stored are always in first hand condition, and the metal parts of agricultural implements cannot be impaired by its use. It is guaranteed to contain 25.71 per cent. of ammonia.

Disinfectant Fluid.—A high grade antiseptic and deodorising fluid for general use in and around farm buildings. It flows freely at all temperatures, is highly concentrated, and mixes completely and easily with hard and soft water in any proportion. A standard test proves it to be four times as powerful in its germicidal action as pure carbolic acid. It contains no caustic alkali, the presence of which lowers the germicidal value of a disinfectant, and, in addition, is likely to prove harmful in certain circumstances where a disinfectant is required. Metro disinfectant fluid is supplied in 5 and 10 gallon drums and 40 gallon casks.

Wood Preservative.—Is specially prepared for direct application to all outdoor woodwork as used for arches, fences and greenhouses in gardens, and pnes, barns, coops, stables and cowsheds on farm estates. Metro wood preservative imparts pleasing nut-brown tints, is evenly constituted, and readily applied with an ordinary brush. Supplied in pale, medium, and dark shades, and in 10, 5 and 2 gollon quantities.

Road Tar.—Produced from pure coal gas tar, and guaranteed to comply with the new No. 1 specification of the Roads Department of the Ministry of Transport.

BRUNNER, MOND & CO., LIMITED.

No exhibition embracing the chemical industry could be regarded as complete unless this well-known firm of alkali manufacturers were included. Brunner, Mond's products are noted throughout the world for their excellence and unvarying purity, and a full range of the company's manufactures is to be seen at their stand. A feature of the exhibit is a practical demonstration of the virtue of their special P.84 silicate of soda for hardening concrete. An abrasion machine is set up, on which blocks of cement are subjected to vigorous treatment. One half of the block has been allowed to absorb the silicate, and on this half the severe friction applied by the machine has little or no effect, whilst the other half, which has not been treated with silicate, wears away rapidly under exactly similar conditions.

Silicate of soda is a substance with many characteristics not generally known. Its solutions, unlike those of most other substances, can be made to vary in two directions. First, the solid silicate from which the solution is made, may contain silica and soda in different proportions; and secondly, the density of the solution may be varied according to the degree of concentration. Each of these changes produces a silicate solution with distinct chemical and physical properties, and the series form a very interesting part of the exhibit.

Thus, two of the grades shown are both 100° Tw., but one is a watery liquid whilst the other is a thick, viscous fluid.

All the products manufactured by the company, soda ash, bicarbonate of soda, soda crystals, caustic soda, silicate of soda, calcium chloride, ammonium chloride, "Crex," crescent laundry soda, carbonate of ammonia, etc., are shown.

A new form of calcium chloride is seen for the first time. It is a pure white crystal, containing 70-75 per cent. of real $CaCl_2$, and is an exceedingly pure form of the product, conforming to the B.P. standard with regard to arsenic content.

THE CASTNER-KELLNER ALKALI CO., LTD.,

famed for their electrolytic caustic soda, have also an interesting display of their products at the same stand. They are the foremost example of the successful exploitation of the manufacture of sodium and chlorine products by the electrolytic process.

The works of the company at Weston Point, Cheshire, are the most scientifically planned and equipped works of their kind in the alkali industry, and being in close proximity to the necessary raw materials and the shipping ports of Liverpool and Manchester, are in a strong position to meet all competition.

The principal products of the company are bleaching powder, caustic soda, hypochlorite of soda, liquid chlorine, sodium peroxide, perborate of soda, hydrochloric acid, chloracetic acid, sulphur chloride, sodium (metallic), chlorine derivatives of ethylene and ethane (including trichlorethylene and tetrachlorethane and kindred products), solvent soaps. Visitors interested in the manufacture of soap, paper, dyes, chemicals, paints, varnishes, rubber, and in the textile industries, oil extraction, sanitation, chlorination of water, laundry works, horticulture, etc., should certainly pay a visit to this stand.

THE ELECTRO BLEACH & BY-PRODUCTS, LTD.

whose works are at Middlewich, Cheshire, is another instance of the successful operation of the electrolytic process. Their first commercial installation of the Hargreaves-Bird Cell was erected at Middlewich in 1900, and although many improvements have been introduced in recent years the basic process, which is being worked with great success by this company, remains essentially the same.

Chlorine gas and sodium carbonate solution are prepared directly by electrolysing the brine pumped from the Cheshire brine-field and introducing steam and carbon dioxide. The chlorine is brought into contact with specially prepared slaked lime which absorbs it to form bleaching powder, or chloride of lime. Soda crystals (washing soda) are made by concentrating and crystallising the sodium carbonate solution, and caustic soda is produced by treating the same solution with lime. The resultant carbonate of lime in a very fine state of division is thoroughly dried in a special rotary dryer, for use in agriculture and for the stone-dusting of mines.

By further carbonating the soda liquor, sesqui carbonate of soda is produced in the form of fine needle-like crystals, and is in great demand for the preparation of bath salts and for use in the laundry.

The company also makes salt direct from brine by the vacuum process of evaporation, and the interesting literature to be obtained at their stand will well repay a visit.

CHANCE & HUNT, LIMITED,

with works at Oldbury, Wednesbury, Stafford and Birmingham, manufacturing high-grade chemicals for a wide variety of trades, are also well represented. Their "Fortress' brand has become a recognised guarantee of excellence.

Special attention is directed to their ammonium carbonate for the biscuit, bakery, and other trades; caustic soda for the textile and soap industries; sulphuric acid for the sulphate of ammonia, fertiliser and metal industries; hydrochloric acid and muriate of ammonia for the galvanising trades, liquid ammonia for laundry, pharmaceutical and domestic purposes, sodium sulphide for the dye and tanning industries, and a specially pure white sodium sulphide for photographic purposes.

For the glass and paper trades a high quality saltcake (sodium sulphate) is manufactured, which is in constant demand by users the world over.

Oxide of iron pigments are manufactured, and are finding increasing favour in the paint and colour trades.

Chance & Hunt possess brine of excellent quality at Stafford, and in very modern plant produce salt of every description. A non-caking, "free running" quality, of full flavour, admirably suited for use in salt cellars and salt pourers, is of particular interest.

The company is prepared to investigate any problems connected with the use of their products, and from time to time, to bring to the notice of their friends any special plant, the utility of which they have themselves proved out in their own works.

Their Calder-Fox scrubber is successfully dealing in many works with the difficult problem of removing the acid mist contained in the exit gases from sulphuric acid concentration plants. Firms having difficulty in this respect are invited to apply to the company for full details and Royalty terms.

(To be continued.)

INTERNATIONAL CONGRESS OF REFRIGERATION.

So close is the mutual relationship of bio-chemistry and refrigeration, that the Fourth International Congress of Refrigeration, to be held in London from June 16 to 21, under the presidency of Sir Gordon H. Campbell, K.B.E., will discuss a number of specially contributed papers on the various phases of this subject.

The features of this congress comprise a considerable number of trips to refrigerating and other establishments, such as the National Physical Laboratory at Teddington, the Port of London Docks, Bristol, Southampton, Liverpool and Manchester.

A large volume of Congress Proceedings, of great interest, will be supplied afterwards to members.

Particulars relating to membership may be obtained on application to Mr. J. Raymond, Hon. Secretary General, Fourth International Congress of Refrigeration, Weavers' Hall, 22, Basinghall Street, London, E.C.2.

FLUXES AND SLAGS IN METAL MELTING AND WORKING.

A General Discussion on the above subject was held on April 28, by the Faraday Society and the Institute of Metals, with the co-operation of the British Non-Ferrous Metals Research Association and the Institute of British Foundrymen.

The following papers were communicated:—

Fluxes for Soft Soldering, by T. B. Crow, M.Sc., M.Inst.Met. (Bower Research Scholar in the University of Birmingham).

The first essential of a good soft soldered join is that an alloy, preferably a solid solution, should be formed by diffusion of at least one of the constituent metals of the solder and the body-metal. The strength of the join depends, *inter alia*, upon the composition and depth of penetration of this alloy, which in their turn depend upon the temperature at which the soldering is carried out. The other component metal of the solder appears to act chiefly in fixing the melting-point of the solder so as to conform more or less to the conditions of temperature just stated. If the second metal does not alloy, its presence simply weakens the join, just as graphite does in cast iron, and might be better eliminated.

In order to make alloying possible, the surfaces of both the solder and the body-metal must be chemically clean and free from oxide. This condition must be maintained until after alloying has occurred. If the metallic surfaces are covered with an oxide film, some method must be adopted for removing it. Most of the inorganic fluxes act in this way, thus enabling clean metals to come together and alloy.

Much experimental work dealing with the various problems was described.

The Use of Fluxes in the Melting of Aluminium and its Alloys, by Walter Rosenhain, B.A., D.Sc., F.Inst.P., F.R.S., and S. L. Archbutt, F.I.C., of the National Physical Laboratory.

The strong chemical affinity of aluminium for oxygen and the consequent rapid formation of oxide when unprotected aluminium, or alloys rich in aluminium, are exposed to contact with air at high temperatures, suggests at first sight that the use of protective coverings, and particularly of fluxes, would be eminently desirable, if not essential, in the melting of these materials. In practice, this is not found to be the case, and a large proportion of industrial melting of aluminium and its light alloys is carried out without the aid of any flux or protective coating whatever. The reason for this practice is not far to seek; it resides in the fact that the oxide skin which is formed on aluminium or alloys rich in aluminium is very tough and appears to be largely impervious to oxygen, with the result that, once formed, it only thickens slowly and serves as an excellent protection to the metal below. It has been suggested that this oxide coating, which consists probably of Al_2O_3, is capable of reacting with molten aluminium in contact with it, forming a sub-oxide which is soluble in and diffuses through the aluminium, which it is supposed to damage. In itself, this suggestion does not appear very probable, in view of the fact that a lower oxide of aluminium is not known to chemists. Further, recent researches on the behaviour of aluminium which has been repeatedly remelted and thus exposed for a prolonged period to the possibility of such an action, has shown conclusively that the material is not damaged by such a proceeding. There is also evidence to indi-

cate that no oxide of aluminium is at all readily soluble in the molten metal and that the formation of oxides both in aluminium and in aluminium-rich alloys is confined essentially to the surface, whether the material be in the liquid or the solid condition.

In these circumstances, one of the main functions for which slags or fluxes are usually employed, namely, that of protecting the surface of the molten metal from oxidation, becomes unnecessary in the case of aluminium or its alloys.

The conclusion to be drawn is that, whenever avoidable, fluxes should not be used in the melting of aluminium and its alloys. The prevention of an undue amount of oxidation is best achieved by minimising the temperature to which the molten metal is exposed, reducing the time of such exposure and carefully avoiding any undue agitation of the surface. It is sometimes thought that aluminium which has been molten and cast, whether pure metal or alloy, contains a considerable amount of oxygen. The view held by the present writers, however, based upon definite experience, is that there is reason to believe that the oxygen content of aluminium, when properly treated, is extremely low.

For remelting of finely divided swarf or scrap a flux, partly consisting of cryolite, has proved very successful in the authors' experience. The mixture used contains 40 per cent. of cryolite and 60 per cent. of potassium chloride. Another mixture recommended by Livermore, contains sodium chloride 85 per cent. and calcium fluoride 15 per cent. These proportions, however, must only be regarded as typical of suitable mixtures for this purpose.

A flux of a very special kind has recently been introduced for a particular purpose in connection with the alloys of aluminium and silicon, known under the trade name of "Alpax," "Silumin," etc. The use of this flux, which is protected by a patent, brings about a modification in the character of the alloy itself, leading to a different method of crystallisation and a very fine microstructure which brings with it superior mechanical properties. The flux in question is a fluoride flux containing a notable proportion of sodium salt, and it is suggested that the molten aluminium-silicon alloy is capable of reducing from this flux a small amount of metallic sodium.

In regard to soldering, which is generally carried out by what are known as aluminium solders consisting as a rule of alloys of zinc, tin and aluminium, the use of various fluxes has from time to time been recommended. A considerable number of tests of aluminium soldering processes and of the resulting joints, carried out both at the Bureau of Standards at Washington, U.S.A., and by the National Physical Laboratory, have led the investigators concerned to come to the conclusion that the use of fluxes in this process is undesirable, and that better results can be obtained in their absence. The use of fluxes in the welding of aluminium and its alloys, however, appears to be a matter of somewhat greater importance.

Fluxing Problems in Welding of Mild Steel with the Metallic Arc, by H. OGDEN, B.A., B.Sc.

The first men to apply the electric arc to effect the union of two pieces of steel by interfusion, Bernados with the carbon arc, and Slavianof with iron wire as the electrode, did so without a flux. In all probability the first weld ever accomplished in iron was made ages ago without flux, for it is well known that some wrought irons, by virtue of their 1½ per cent. of low fusible cinder, flux themselves. With the purer metal steel it is usual in forge welding to use an added flux, usually sand or borate, the function of which is to protect the hot metal from contamination by the fuel and oxygen of the air, and to form with the scale a low fusible slag, which is squeezed from between the welding faces by external pressure. It is suggested that this use of flux in forge welding first turned the attention of such pioneers of arc welding as Pommee to the possibilities of the similar use of flux in arc welding. It is known that the first attempts at fluxing were made by dusting the weld with the smith's flux during its formation under the arc, but this method was quickly replaced by the aromatic method of applying the flux as a coating on the welding wire. The foremost fluxing problem in arc welding is the protection of the molten metal in the neighbourhood of the arc from the atmosphere, and any substance introduced to achieve this end will be included under the name of flux, whether or not the substance is a flux in the true sense of the word. When the high temperatures which obtain in the arc

are considered, it will be seen that to protect the arc is no very simple matter, for it is certain that part of the iron is vaporised and the highest temperature of the molten metal is only limited by the boiling-point of iron.

As secondary considerations, a welding flux should contain substances of high thermionic emissivity, such as the oxides of the alkaline earths, which tend to yield a stable arc giving a smooth running electrode, and also tend to localise the arc, thereby increasing its penetrating power. Moreover, the flux should consume evenly with the wire, and if producing a slag this should be limpid in character, for if it were viscous it would more easily be trapped in the weld. Other physical properties of the slag should also be attended to, so that there is least danger of the slag causing inclusions in the weld and blowholes.

In the patent literature of arc welding fluxes the claims are that the flux protects the deposited metal from oxidation during the welding process and yields a smooth working electrode, coupled with the special means by which the flux is applied, and fixed to the wire. Some also claim to make good the loss of various constituents sustained by the electrode material in passing across the arc, and others to combine with the oxide in the deposit, which oxide passes into the removable slag instead of remaining in the weld, both of which claims point to incomplete protection from atmospheric attack by the flux.

The writer firmly believes that a suitable flux, manipulated by a conscientious and capable welder, gives a weld of superior mechanical properties.

Slag Inclusions in Relation to Fatigue, by PROFESSOR B. P. HAIGH, M.B.E., D.SC., M.INST.C.E.

The general view based on practical experience, that slag inclusions in an otherwise sound metal tend to promote fatigue, is supported by experimental research, but appears to require further investigation. It is probable that different slags have widely different effects; and, also, that the effect of a given slag may depend on how the stress varies—whether as a pulsating or as an alternating stress that reverses its direction.

Considerable difficulty is experienced in analysing the results of fatigue tests to ascertain the effects of slag, because it is seldom possible to compare two samples that differ only in the character or amount of slag present. Experimental evidence indicating the harmful effect of slag may be classified in three categories, as follow:

(1) When a machine part or test-piece fails prematurely under a moderate range of stress that might be expected to be safe, it is commonly observed that the crack starts from a slag vein and thence spreads through sound metal, forming a characteristic fracture with shell-like markings. The appearance suggests that the vein acts as a scratch or other discontinuity of form; thus the cracks start from both sides of the vein, where projections are discernable, and do not commonly cross the vein.

(2) In determining the fatigue limit of a sample of metal, it is customary to test a number of identical test-pieces under different ranges of stress and to record the endurances—which may run from a few tens of thousands to several millions of cycles of stress before fracture occurs. On plotting the stresses against the endurances the points are found to lie on a regular graph if the metal is of uniform quality, or in a zone bounded by a pair of similar graphs if the metal be non-homogeneous. The width of the zone intercepted between the two graphs often affords some quantitative measure of the influence of slag inclusions irregularly distributed through the metal.

(3) Considerable experience of fatigue testing indicates that, although the ratio between the fatigue limit and the tensile elastic limit varies very widely in different metals or in the same metal with different heat treatments, and may be either greater or less than unity, the ratio between the fatigue limit and the ultimate tensile strength varies only in less degree at least in metals free from slag. The value of this ratio appears hardly ever to exceed 0.60, which value is reached only in the best qualities of drawn bronzes and in the mildest steels and irons free from slag; and seldom falls below 0.40 in metals free from slag inclusions. Since the presence of slag, however, reduces the tensile strength only slightly, and the fatigue strength in much greater degree, the value of the ratio falls when slag is present.

There appear to be at least three distinct

ways in which slags may influence the fatigue strength of a metal:

(1) *Chemically.*—The slag may supply elements or compounds that enter into solution in the metal, so that it becomes brittle. But since the fatigue limit of even a brittle solution is quite commonly higher than that of the ductile solute metal, it appears improbable that this action is generally important. In certain circumstances, however, the presence of such a brittle layer, surrounding the slag, might definitely accentuate the actions mentioned below.

(2) *Expansively.*—Since the thermal expansions of slag and metal usually differ widely, the process of cooling may cause the slag to exert severe stresses, acting as fluid pressure or as shear stress, and of such intensity as may strain the surrounding metal beyond its elastic limit. Or the slag may shrink away from the metal, forming a cavity.

(3) *Elastically.*—Since the elastic constants of the slag and metal differ widely, any applied load will produce concentrations of stress at and near the boundary zones between the slag and metal, even though the surfaces may be, initially, free from stress.

In the view of the author, the first action operates only in a manner that influences the predominating actions of the second and third effects; and even the second action is of importance, chiefly, as tending to change the action of the third. The action of slag is regarded, therefore, as almost equivalent to the action of cavities, scratches and other discontinuities of form; and different chiefly in respect that the elastic resistance of the slag inclusion is comparable with that of the surrounding metal.

(*To be continued.*)

PROCEEDINGS AND NOTICES OF SOCIETIES.

THE CHEMICAL SOCIETY.

May 1.

Papers read:—

The Electrometric Titration of Chromic Acid using (a) The Hydrogen Electrode, and (b) the Oxygen Electrode, by H. T. S. Britton.

Chromic acid has been titrated electrometrically with sodium hydroxide by means of the hydrogen electrode and also the oxygen electrode. Essential points to be observed in preparing hydrogen electrodes for use in presence of chromic acid, chromates and nitrates were recorded. Evidence showed that chromic acid dissociated as a normal dibasic acid. The dissociation H_2CrO_4 $H^{\cdot} + HCrO_4{}'$ is almost complete in dilute solution, but the dissociation of the hydrochromate ion, thus $HCrO_4{}'$ $H + CrO_4{}''$, is small. The second dissociation constant is 4.4×10^{-7} at 18° C. The use of the oxygen electrode as an indicator of both H-ion concentrations and end-points has been demonstrated by comparison with the hydrogen electrode. The dibasicity of chromic acid, as H_2CrO_4, accounts for some of the reactions of chromic acid and its salts.

Imino-dihydro-1 : 2 : 3-triazole. Part II. Intra Annular Migration of the Dyad Type and Intra Nuclear Tautomerism without Migration, by Miss H. W. Carnelley and P. K. Dutt.

The reaction between 1 : 4-diphenyl-5-chloro-1 : 2 : 3-triazole and *p*-toluidine on the one hand and that between 1-*p*-tolyl-4-phenyl-5-chloro-1 : 2-3-triazole and aniline on the other, lead to the formation of the same two tautomeric products.

The Formation of Triphenylmethylphosphinic Acid from Triphenylmethoxyphosphorus Dichloride, by D. R. Boyd and F. J. Smith.

The acid obtained from triphenylmethoxyphosphorus dichloride by the action of alcoholic potash is shown to be a phosphinic acid of the formula $(C_6H_5)_3C \cdot PO(OH)_2$, and not a phosphorous acid ester of triphenyl-carbinol as originally supposed.

During the hydrolysis of the phosphorus chloride, a molecular rearrangement must occur, analogous to the change which diethyl sulphite undergoes with aqueous potash.

$$(C_6H_5)_3C \cdot O \cdot PCl_2 + 3KOH + C_2H_5 \cdot OH$$

$$= (C_6H_5)_3C{-}P{\overset{\displaystyle /\!\!/ O}{\underset{\displaystyle \diagdown OK}{-}}}OC_2H_5 + 2KCl + 2H_2O.$$

Triphenylmethylphosphinic acid is obtained in small quantity when the mixture of products formed by the action of phosphorus trichloride on triphenyl-carbinol is treated with water.

May 15.

Papers read:—

The Bromo-Derivatives of 1-methylglyoxaline and the Constitution of "Chloroxalmethylin," by I. E. Balaban and F. L. Pyman.

Synthesis of amygdalin, by R. Campbell and W. N. Haworth.

Reactivity and Radiation—The Photochemical Union of Hydrogen and Sulphur, by R. G. W. Norrish and E. K. Rideal.

MINING AND METALLURGICAL CONGRESS.

An Empire Mining and Metallurgical Congress will be held at the British Empire Exhibition, from June 3 to June 6.

The Congress has for its chief objects:

(*a*) The discussion of papers dealing with the scientific, technical, and economic problems connected with the development of the mineral resources of the Empire, and the mining and metallurgical industries.

(*b*) The constitution of an Empire Council of Mining and Metallurgical Engineering Institutions, whose principal functions would be:

1 To serve as an organ of intercommunication between the co-operating institutions, and to promote the interests of the professions and industries.
2 To create and maintain throughout the Empire a high standard of technical efficiency and professional status.
3 To convene successive Congresses within the Empire.
4 To establish, if it be found after discussion by the Empire Council and the co-operating Institutions to be necessary or desirable, a Register of British Mining and Metallurgical Engineers.

Spectroscopy, by E. C. C. Baly, C.B.E.,

THE ROYAL SOCIETY.

Thursday, May 15.

The Bakerian Lecture was delivered by Prof. A. Fowler, F.R.S., on *The Spectra of Silicon at Successive Stages of Ionisation*. The lecture was preceded by the election of new Fellows.

BOOK RECEIVED.

M.Sc., F.R.S. Pp. XI. + 298. Vol. 1, 3rd Edition, 1924. Messrs. Longmans, Green & Co. 39. Paternoster Row. E.C.4. 14s.

THE ROYAL INSTITUTION.

A General Meeting of the members of the Royal Institution was held on May 5, Sir James Crichton-Browne, Treasurer and *Vice-President, in the chair.*

Mr. James D. Hamilton Dickson, Mr. Frank Elmore, Dr. Wilfred Harris, Dr. David Heron, Mr. Austin Y. Hoy, Sir Frederick Keeble, Lady Keeble, Mr. C. L. Long, Mr. Ralph Lucas, Mr. E. K. Maxwell, Dr. David Roxburgh, Lieut. A. S. D. Ryder, Mr. F. E. Smith, Mr. Herbert Spencer, and Dr. E. H. Starling were elected members.

ROYAL VISIT TO THE CHEMICAL HALL AT WEMBLEY.

On Friday, May 2, their Majesties the King and Queen, accompanied by the Duke and Duchess of York, paid an informal visit to the Exhibition at Wembley.

After visiting the Palace of Engineering they made a tour of the Palace of Industry, including the Chemical Hall.

The Royal Party was received at one of the entrances and conducted through the Hall by the General Manager of the Association of British Chemical Manufacturers. They spent some time in the Scientific Section, where the interesting exhibits by Sir John Russell representing agriculture, and by Sir Robert Robertson showing explosives, were noted. A copy of "Chemistry in the Twentieth Century" caught the attention of the King, who had previously accepted a specially bound copy for his own library. Some ancient Egyptian dyed fabrics were also displayed, and, as a companion exhibit, the original specimen of mauve, the historic discovery of the late Sir William Perkin. The visitors were also interested in the display of ancient appliances for producing fire before the days of matches, shown in the cottage of Messrs. Bryant & May. The crystals shown by Messrs. Peter Spence & Co. also were noticed, as well as the puppets on the stand of Messrs. Yardley.

Before leaving, the King and Queen expressed to Mr. Woolcock their pleasure at what had been shown them.

NOTICES OF BOOKS.

Handbuch der Spectroscopie, von H. Kayser und H. Konen, Band 7. Pp. 498 + X. 1924. Verlag von S. Hirzel in Leipzig, Germany. 30 Marks (geheftet).

This handbook on spectroscopy is of a well-known set, and we are pleased to announce Volume VII. (first issue). The material of this book is a record of the spectral lines in connection with the following elements: Argon, silver, aluminium, archonium, arsenic, gold, barium, bismuth, bromine, carbon, calcium, cadmium, *cerium, chlorine, cobalt, chromium*, cæsium, copper, dysprosium, erbium, iron. Air lines are also given, and also the spectrum of the Northern Lights. The last-named contains references to Vegard, J. Stark, Slipher, and Lord Rayleigh.

On page 60 a brief mention is made of archonium, which is a hypothetical element. Wave-lengths and other data are given. The work of Bourget, Fabry, Buisson, J. W. Nicholson, and W. H. Wright is referred to. We are glad to note that attention is being paid to the lines of nebulæ and the speculative matter in connection therewith.

From the spectral lines of nebulæ, Wolf-Rayet stars, and novæ, Nicholson calculated, on the basis of known hypotheses, the spectra and atomic weight of the most simple atomic structure. Thus he finds that an element, the nucleus of which contains six electrons, must emit line λ 3484, which is observed in the Wolf-Rayet stars, and it must have the atomic weight of 2.947. This element he has termed archonium. Bourget, Fabry and Buisson have now made a practical application of their interference methods to the study, the nebula of Orion. The magnitude of the interferences observed depending on the breadth of the lines, goes to show that the movement of the atom is involved according to the Doppler effect, and there is a dependence upon the atomic weight of the element present. Fabry and his collaborators concluded that the line 3729 in the nebula of Orion was therefore produced by an element of atomic weight a little below 3. Nicholson now regards this element as his archonium. This element may correspond to or be responsible for the set of lines 3484, 3729, 4068.8, as observed by Wright in nebulæ. Recently the French experimenters have estimated the wave-length of the line "3729" to be 3728.838 and the atomic weight to be 2.74.

Wright noticed that a strong line, λ 3726, lies near line λ 3728, and from the position of these lines one must conclude that some relationship exists.

Works of this high standard are important contributions to science, and no special comment need be made except to express a desire to see further additions to the set as early as possible.

New Patents.

This list is specially compiled for *The Chemical News* by Messrs. Rayner & Co., Registered Patent Agents, of 5, Chancery Lane, London, from whom all information relating to Patents, Trade Marks, and Designs can be obtained gratuitously.

Latest Patent Applications.

9590—Cassella & Co., Ges. L.—Manufacture of arsenic compounds of the aromatic series. April 15.

9859—Slatineanu, E.—Carrying out chemical reactions. April 17.

Specifications Published this Week.

213638—Harris, H.—Separation of arsenic and tin in presence or absence of antimony.

192089—Deschamps, J. J.—Method of and means for facilitating physical or chemical reactions in masses of loose material.

213711—Lund, W.—Production of alkali salts of higher fatty acids.

204721—Farbwerke vorm. Meister Lucius & Bruning.—Manufacture of arseno-benzene derivatives.

Abstract Published this Week.

212065—Gels, catalytic agents, adsorbents for *fluids*.—Silica *Gel Corporation*, 239, Redwood St., and Patrick, W. A., The Terraces, Mt. Washington, both in Baltimore, Maryland, U.S.A.

Aluminium, tin, titanium, and tungsten oxides.—A gel for use as a catalytic agent and as an adsorbent for fluids, and consisting of an oxide of aluminium, tin, titanium, or tungsten, or a mixture of two or more of them, or of silica with one or more of them, is prepared by mixing with vigorous stirring a solution of an aluminate, stannate, titanate, or tungstate with or without a silicate and an acid in such proportions that no appreciable precipitation occurs at first, but the reaction mixture, after a predetermined time, such as 2 to 5 hours, sets completely to a hydrogel. The hydrogel is then broken up, washed, and dried. A quantity of acid in excess of that necessary to combine with the alkali metal present is employed. The drying of the washed hydrogel may be effected in a stream of air at 75-120° C. and then at 300-400° C. or the second stage of the drying may be effected in a vacuum at 75-120°.

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n Blount. Cement. (Longmans.) 1st Ed., 1920. 284 pp. 18s. Our Price, 8s.

Bloxam. Chemistry, Inorganic and Organic. (Churchill.) 6th and 8th Editions, 1888 and 1895. Prices, 6s. and 8s.

N. Bluett. Report on the Economic Situation of the Netherlands East Indies. (H.M. Static Office.) 1st Ed., 1923. 112 pp. 3s. Our Price, 1s.

Bolton. A Select Bibliography of Chemistry. (Smithsonian Institution.) 1893-1904. 3 Vols. Price, 10s.

A. Bone. *Coal and its Scientific Uses.* (Longmans.) 1st Ed., 1918. 491 pp. £1 1s. Our I 10s.

. Boone. A Complete Course of Volumetric Analysis. (Blackie.) 1st Ed., 1918. 164 pp. 8s Our Price, 2s.

Borchers. Elektro-Metallurgie. (Leipzig.) 1902-3. 2 Vols. Our Price, 10s.

orn. The Constitution of Matter. (Methuen.) 1st Ed., 1923. 80 pp. 6s.

chonnet. Bismuth, Etain, Plomb. (Paris.) 1st Ed., 1920. 370 pp. Our Price, 5s.

tarie and A. Ravnaud. Phosphore, Arsenic, Antimoine. (Paris.) 1st Ed., 1920. 417 pp. Our P 5s.

Boyle. The Ventilation of Public Buildings. 1st Ed., 1923. 51 pp. 6s. Our Price, 3s.

T. Brannt. Practical Dry Cleaner, Scourer and Garment Dyer. (Hodder & Stoughton.) 5th 919. 378 pp. 15s. Our Price, 7s.

C. Bray and Wendell M. Latimer. A Course in General Chemistry. (Macmillan.) 1st Ed., 1 48 pp.

Association for the Advancement of Science. 2nd and 5th Reports on Colloid Chemistry and eneral and Industrial Applications. 1st Ed., 1919-1923. (H.M. Stationery Office.) 1s. 6d. s. 6d. Our Prices, 1s. and 2s.

in T. Brooks. The Chemistry of the Non-Benzenoid Hydrocarbons and their Simple Derivat Chemical Catalog Co., Inc.) 1st Ed., 1922. 612 pp. $7. Our Price, 12s.

. Browning. *Introduction to the Rarer Elements.* (Chapman & Hall.) 2nd and 3rd Eds., 1908 912. Our Price, 3s.

uchanan. Scientific Papers, Vol. 1. (Cambridge University Press.) 1st Ed., 1913. Our Price,

Bunbury. The Destructive Distillation of Wood. (Benn Brothers.) 1st Ed., 1923. 320 pp. 3:

nnell Cain. Manufacture of Intermediate Products for Dyes. (Macmillan.) 1st Ed., 1918. p. 10s. Our Price, 6s.

Campbell. Petroleum Refining. (Charles Griffin.) 1st Ed., 1918. 297 pp. £1 5s. Our Price,

rleton and Annie Louise Macleod. Vital Factors of Foods—Vitamins and Nutrition. (Chapm all.) 1st Ed., 1923. 391 pp. 25s.

[*Further Lists of Important Works will be advertised next week.*]

U.S. DEPARTMENT OF THE INTERIOR, BUREAU OF MINES.

Stone Dusting or Rock Dusting to prevent Coal-dust Explosions, as practised in Great Britain and France, by GEORGE S. RICE. Pp. 57.

Quarry Accidents in the United States during the Calendar Year 1922, by WILLIAM W. ADAMS. Pp. V. + 61.

Carbon Monoxide Hazards from House Heaters Burning Natural Gas, by G. W. JONES, L. B. BERGER and W. F. HOLBROOK. Pp. IV. + 31.

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BUILDING FOR PEACE, II.

A SET of Letters on International Problems by Marie of Paris, Grignard of Lyons, Wieland of Freiburg, Stock of Berlin, Rabn of Kiel and Hewitt of Heston, with replies and a proposal for the settlement of "Reparations" by Noyes of the University of Illinois. Heffer & Sons, Cambridge, Price 1s. 6d. French Translation, La Revue Mondiale, Paris; German, Akademische Verlagsgesellschaft, Leipzig. "An earnest and valuable contribution towards the attainment of a just and lasting settlement."—J.F.G.D. in *Chemical News*. "The differences between Germany, France and the rest of the world must be ended in some other way than by hrutal force and continued contempt."— Grossmann, in *Chemiker Zeitung*.

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THE CHEMICAL NEWS,

VOL. CXXVIII. No. 3345.

THE CONSTITUTION OF THE THIONIC ACIDS.

By I. Vogel.

Dalton was apparently the first to obtain the thionic acids, for in his book, "A New System of Chemical Philosophy," p. 384 (1808) we find the following statement:—

"When sulphuretted hydrogen and sulphurous acid are mixed over mercury in the proportion of six measures of the former to five of the latter, both gases lose their elasticity, and a solid is deposited on the sides of the tube. The common explanation given of this fact is that the hydrogen of one gas unites to the oxygen of the other to form water, and the sulphur of both gases is precipitated. This explanation is not correct; water is indeed formed, as stated: but the deposition consists of a mixture of solid bodies, the one sulphur, the other sulphurous oxide; they may be distinguished by their colour; the former is yellow, the latter bluish-white, and when they are both thrown into water, the former soon falls down, but the latter remains for a long time suspended in the water and gives it a milky appearance, which it retains after filtration." (Thus Dalton discovered colloidal sulphur.)

"Again, if water impregnated with each of the gases, be mixed together till a mutual saturation takes place or until the smell of neither gas is observed after agitation; a milky liquid is obtained which may be kept for some weeks without any sensible change or tendency to precipitation. Its taste is bitter and somewhat acid, very different from a mixture of sulphur and water. When boiled, sulphur is precipitated, and sulphuric acid is found in the clear liquid. The milkiness of the liquid seems owing, therefore, to the oxide of sulphur."

It is thus evident that Dalton had undoubtedly prepared a mixture of the thionic acids and observed some of their properties. He makes an attempt to explain the reaction as follows: "Oxide of sulphur, or sulphurous oxide, is formed when there is not sufficient oxygen to form sulphurous acid." Dalton seems to think that sulphurous oxide is a compound of one atom of sulphur and one atom of oxygen. These facts are essentially correct; the last suggestion has been employed as the basis of the latest theory of the formation of the above solution, but recent German authors (*Z. Anorg. Chem.*, 1921, CXIX., 225) do not mention Dalton.

Thomson, in 1818 (*Ann. Phil.*, 1818. XII., 442), had also observed that an acid solution was formed on mixing solutions of the two gases, and suggested the name, hydrosulphurous acid.

Welter and Gay-Lussac (*Ann. Chim. et Phys.*, 1826, X., 313) discovered hyposulphuric acid (dithionic acid) in 1826; their method of preparation is still used. Finely ground pyrolusite is suspended in water and treated with a current of sulphurous acid gas until all the pyrolusite is decomposed, the solution neutralised with baryta, and the excess of baryta precipitated with carbonic acid gas; the resulting solution is concentrated and allowed to crystallise; colourless crystals of barium hyposulphate separate. These were decomposed with sulphuric acid, and a solution of the free acid obtained. The acid was called hyposulphuric acid, since it contained "more oxygen than sulphurous and less than sulphuric acid." The composition of the acid was determined and found to consist of "two proportions of sulphur, five proportions of oxygen gas, and a varying quantity of water, which is essential for its existence when isolated from bases."

Langlois (*Compt. Rend.*, 1840, X., 461), in 1840, found, by digesting flowers of sulphur with potassium bisulphite and crystallising, that the salt of a new acid—"sulphurated hyposulphuric acid"—was obtained. The free acid, now known as trithionic acid, was prepared by decomposing the potassium salt with tartaric or perchloric acid. The modern method of preparation of trithionates from thiosulphates is due to Plessy (*J. Prakt. Chem.*, 1844, XXXIII., 348).

Fordos and Gelis (*Compt. Rend.*, 1842, XV., 920) observed that on addition of iodine to a solution of sodium hyposulphite (sodium thiosulphate) until the latter was yellow, that a salt crystallised out, the solution of which, on boiling, decomposed into "sulphurous acid, sulphuric acid, and twice as much sulphur as yielded by Langlois' acid"; they therefore called the new acid "bisulphurated hyposulphuric acid."

The free acid was obtained by decomposing the barium salt with sulphuric acid. The formulæ of the various hyposulphuric acids then known are given as follows:—

Hyposulphuric acid (dithionic acid), S_2O_5; sulphurated hyposulphuric acid (trithionic acid), S_3O_5; bisulphurated hyposulphuric acid (tetrathionic acid), S_4O_5.

The *discovery of pentathionic acid* is usually, but incorrectly, ascribed to Wackenroder (*Annal. de Pharmacie*, 1845, LX., 189), in 1845. He claimed to have discovered a new acid by passing sulphuretted hydrogen into a saturated solution of sulphurous acid gas, digesting the milky solution with copper, removing the dissolved copper from the clear solution by a current of sulphuretted hydrogen, and finally concentrating the solution to a specific gravity of 1.37—further concentration resulted in complete decomposition. Wackenroder calls the concentrated solution pentathionic acid, to which he gives the formula, S_5O_5. He did not isolate any salts, his sole evidence for the existence of the acid were his analyses of the neutralised solution, the results of which differed amongst themselves by as much as 25 per cent. It was not until 1883 that the pure potassium salt of pentathionic acid was prepared by Shaw (*J. Chem. Soc.*, 1883, XLIII., 352).

The first attempts to determine the actual constitution of the thionic acids are due to Blomstrand (*Chemie der Jetztzeit*, p. 157), and Mendeléeff (*Berichte*, 1870, III., 870). Mendeléeff considers the thionic acids to be sulphonic acids which are formed by the substitution of the SO_3H radical in hydrogen and in the hydrogen persulphides as follows:—

H_2 . $H.SO_3H = H_2SO_3$ (sulphurous acid)
$(SO_3H)_2 = H_2S_2O_6$ (dithionic acid)
H_2S $SH.SO_3H = H_2S_2O_3$ (thiosulphuric acid)
$S(SO_3H)_2 = H_2S_3O_6$ (trithionic acid).
H_2S_2 $S_2H.SO_3H = H_2S_3O_3$ (unknown)
$S_2(SO_3H)_2 = H_2S_4O_6$ (tetrathionic acid)
H_2S_3 $S_3H.SO_3H = H_2S_4O_3$ (unknown)
$S_3(SO_3H)_2 = H_2S_5O_6$ (pentathionic acid)

He assumes the unsymmetrical formula for sulphurous acid, *i.e.*, $H.SO_2.OH$, and thus arrives at the following formulæ for the thionic acids:—

$$\begin{array}{c}SO_2.OH\\|\\SO_2.OH\end{array} \qquad S < \begin{array}{c}SO_2.OH\\SO_2.OH\end{array}$$

Dithionic acid. Trithionic acid.

$$\begin{array}{c}S.SO_2.OH\\|\\S.SO_2.OH\end{array} \qquad S < \begin{array}{c}S.SO_2.OH\\S.SO_2.OH\end{array}$$

Tetrathionic acid. Pentathionic acid.

Michaelis (*Annalen*, 1870, XXXVII., 170), assuming the symmetrical formula, SO.OH.OH, arrived at the following set of formulæ almost simultaneously:—

$$\begin{array}{c}SO.OH.O\\|\\SO.OH.O\end{array} \qquad \begin{array}{c}SO.OH.O\\SO.OH.O\end{array} > S$$

Dithionic acid *Trithionic acid*

$$\begin{array}{c}SO.OH.O.S.\\|\\SO.OH.O.S.\end{array} \qquad \begin{array}{c}SO.OH.O.S.\\SO.OH.O.S.\end{array} > S$$

Tetrathionic acid Pentathionic acid

No significant experimental evidence was given in support of the formulæ; they were purely speculative at the time.

The first experimental work on the thionic acids done with a view of establishing their constitution, was carried out by Spring (*Berichte*, 1874, I., 1161), in 1874. Iodine was used as the condensing agent, and sodium, in the form of amalgam, as the "decomposition agent." One example will suffice to indicate the nature of the work; treatment of sodium dithionate with the calculated quantity of sodium amalgam yielded two molecules of sodium sulphite for each molecule of sodium dithionate employed. This was given by all as supporting the Mendeléeff-Blomstrand formula, thus:—

$$\begin{array}{c}SO_2.ONa\\|\\SO_2.ONa\end{array} + \begin{array}{c}Na\\ \\Na\end{array} = \begin{array}{c}SO_2.ONa.Na\\+\\SO_2.ONa.Na\end{array}$$

but it can equally be cited in support of the Michaelis formula, as follows:—

$$\begin{array}{c}SO.ONa.O\\|\\SO.ONa.O\end{array} + \begin{array}{c}Na\\ \\Na\end{array} = \begin{array}{c}SO.ONa.ONa\\+\\SO.ONa.ONa\end{array}$$

Recent work has cast considerable doubt on some of Spring's work.

Before considering later work, the consti-

tution of thiosulphuric acid, which forms the basis of Debus' formulæ, must be briefly considered. Odling, in 1855 (*J. Chem. Soc.* 1855, VII., 7; *ibid.*, 1869, XXII., 254) suggested $SO_2 < \begin{array}{l} SH \\ SH \end{array}$ as a probable formula for thiosulphuric acid. The correctness of this formula was settled beyond question by Bunte (*Berichte*, 1874, VII., 646); sodium thiosulphate was treated with an equivalent amount of ethyl bromide, when sodium ethyl thiosulphate was produced; the latter, on hydrolysis, yields mercaptan and sodium hydrogen sulphate. The reaction, which was shown *to be quantitative, can only be explained* on the basis of the above formula for thiosulphuric acid.

$$SO_2 < \begin{array}{l} SNa \\ ONa \end{array} + \begin{array}{c} Br \\ | \\ C_2H_5 \end{array} = SO_2 < \begin{array}{l} SC_2H_5 \\ ONa \end{array} + NaBr$$

$$SO_2 < \begin{array}{l} SC_2H_5 \\ ONa \end{array} + \begin{array}{c} H \\ | \\ OH \end{array} = SO_2 < \begin{array}{l} OH \\ ONa \end{array} + C_2H_5SH$$

Debus (*J. Chem. Soc.*, 1888, LIII., 280), after a thorough investigation of Wackenroder's—more correctly termed Dalton's—solution, concluded that it contained small drops of sulphur in suspension, a new variety of sulphur which he called δ-sulphur, sulphuric acid, a trace of trithionic acid, tetrathionic acid, pentathionic acid, and a new polythionic acid with more sulphur than corresponded to pentathionic acid, and therefore probably hexathionic acid. The high sulphur content was practically the only evidence in support of the existence of hexathionic acid; Debus was unable to prepare either the acid or the salt in a state of purity, and the properties were almost identical with those of pentathionic acid. Recent work of Riesenfeld and Feld (*Z. Anorg. Chem.*, 1921, CXIX., 225) seems to indicate that the so-called hexathionate consists of a mixture of pentathionate and sulphur. Debus then considers the structure of the polythionic acids. He takes K.SO$_2$.OK and K.S.SO$_2$.OK as the formulæ for potassium sulphite and thiosulphate respectively. It will be observed that they both contain the KSO$_2$ group; Debus attributes the power of compounds to take up sulphur to the presence of this group. Some thiosulphates, *e.g.*, calcium thiosulphate, readily lose sulphur and are converted back into sulphites, hence the sulphur of the thiosulphates is attached by a "feeble force." Potassium thiosulphate reacts with iodine to produce potassium tetrathionate.

$$K_2S_2O_3 + I_2 = K_2S_4O_6 + 2KI.$$

Three formulæ are possible for potassium tetrathionate, thus:—

$$\begin{array}{c} KS.SO_2.OK \\ + \\ KS.SO_2.OK \end{array} + I_2 = 2KI + \begin{array}{c} S.SO_2.OK \\ | \\ S.SO_2.OK \end{array} \quad (1)$$

$$\begin{array}{c} KS.SO_2.OK \\ + \\ KS.SO_2.OK \end{array} + I_2 = 2KI + \begin{array}{c} KS.SO_2.O \\ | \\ KS.SO_2.O \end{array} \quad (2)$$

$$\begin{array}{c} KS.SO_2.OK \\ + \\ KO.SO_2.SK \end{array} + I_2 = 2KI + \begin{array}{c} KS.SO_2.O \\ | \\ KO.SO_2.S \end{array} \quad (3)$$

Potassium tetrathionate, under certain conditions, loses an atom of sulphur and is converted into the trithionate; hence three formulæ are also possible for potassium trithionate:—

$$S < \begin{array}{l} SO_2.OK \\ SO_2.OK \end{array} \quad (4) \qquad \begin{array}{c} KSO_2.O \\ | \\ KS.SO_2.O \end{array} \quad (5) \qquad \begin{array}{c} KSO_2.O \\ | \\ KO.SO_2.S \end{array} \quad (6)$$

Now the power to take up sulphur belongs, as we have seen, to the KSO$_2$ group; formula (4) does not contain this group, and is therefore not the correct formula. "Trithionates behave towards sulphur as an element"; if a sulphur atom is removed the residue simultaneously breaks up into $K_2SO_4 + SO_2$, and from these the original salt cannot be obtained by direct combination. *Loss of one atom of sulphur from (5) gives potassium dithionate containing the* KSO$_2$ group; it should therefore combine *with sulphur to re-form the original trithionate*, hence this formula is incorrect, and (6) remains as the correct formula for trithionate. It follows that (3) is potassium tetrathionate, and the following potassium pentathionate:

$$\begin{array}{c} KS_2.SO_2.O \\ | \\ KO.SO_2.S \end{array}$$

(To be continued.)

FLUXES AND SLAGS IN METAL MELTING AND WORKING.

(*Continued from page 320.*)

A General Discussion on the above subject was held on April 28, by the Faraday Society and the Institute of Metals, with the co-operation of the British Non-Ferrous Metals Research Association and the Institute of British Foundrymen.

The following papers were communicated:—

Fluxes in the Tinplate Industry, by T. LEWIS BAILEY, PH.D., F.I.C.

In the early days of tinplate manufacture (Réaumur, 1725), the iron sheets, after being pickled in water acidulated by the action of fermenting barley meal, were dipped into molten tin, which was covered with "grease" of suitable character.

Sal ammoniac, dissolved in water, had been tried for preliminary treatment of the pickled plates prior to their being dipped into tin, but without much success.

In 1760, in England, muriatic acid was used as pickling agent, and in 1806 sulphuric acid came into use for this purpose.

Prior to the employment of zinc chloride as a "flux" the actual tinning process consisted in:—

(1) Immersing the pickled sheets in molten grease (palm oil).

(2) Immersing in molten tin covered with palm oil.

(3) Immersing in molten tin at somewhat lower temperature.

(4) Standing for a while in molten palm oil, kept sufficiently hot to allow the excess tin to run off.

(5) Standing in a cooler pot containing molten tallow.

In the present method, the pickled and washed sheets are passed wet through a 3 in. or 4 in. layer of a strong neutral solution of zinc chloride into the molten tin on which the zinc chloride floats. Emerging from the tinning pot (they are carried along by mechanical means) the sheets pass upwards through a series of rolls working in the "grease pot," which is filled with molten palm oil; the pressure of the rolls removes the surplus tin, the primary object of the hot palm oil being apparently to keep the tin coating in a condition to allow of such removal.

Comparing the old and the newer methods, it seems doubtful whether the palm oil in the preliminary treatment of early days really acts as a flux. The iron sheets at the moment of their introduction into the molten tin must be dry, free from oxide and at any rate not cold. The pickled sheets are kept covered with water right up to the moment when they can be transferred to the tinning operations, so that a wet sheet is to be dealt with. The essential functions of the old preliminary "grease" treatment would thus appear to be (*a*) to dry the sheet, (*b*) to prevent oxidation of the surface during the operation of immersing in the bath of tin; and the object of the "grease" on the bath of tin would be to prevent the formation of an oxide scum on this bath.

The manufacture of terneplate (coating with a lead-tin alloy) follows much the same lines as that of tinplate proper in its mechanical details. Zinc chloride is used as flux, as in the case of tinplate, but resin takes the place of palm oil.

Slags from Lead, Copper, and Other Blast Furnaces. (Notes by MR. GILBERT RIGG, Consulting Metallurgist to the Zinc Producers' Association of Australia.)

In the hands of trained men equipped with proper apparatus, the study of the physics and physico-chemistry of slags, fluxes, clinkers and sinters, cannot fail to be of great interest both from the scientific and practical point of view.

One of the main difficulties from the metallurgical point of view in getting at an exact knowledge of furnace slags is, that once outside the furnace, they are withdrawn from the conditions under which they originated, and investigation by means of chemical analysis or of thin sections under the microscope does not necessarily indicate what the constitution of the slag was whilst still molten in the furnace, and in contact with red-hot coke, CO, and other cases, matte, metal, etc. Quite possibly the presence of dissolved gases has not a little to do with the physical behaviour of the slag, and in this connection the slag from the mangano-speigel furnace, as it runs into the slag pot is of great interest, as it gives off abundance of CO, and the surface of the slag in the pot is covered with jets of flame, which gradually die away as the slag cools. On the other hand slices of the frozen slag under the microscope give no indication of porosity or anything else that might lead one to assume the existence

of dissolved gas. It is quite possible that the presence of this dissolved gas has a substantial effect on the fluidity of the slag, a most important factor in furnace work.

How far dissolved carbon monoxide acts in keeping the slag free from metallic oxides, and in what way and to what extent the composition of the slag influences its power to dissolve this gas, are matters of interest to metallurgists.

Mangano-speigel slag generally carries from 4 to 5 per cent. of manganese, has a strong green colour, and is quite opaque. In thin slices under the microscope it consisted of a clear, colourless, crystalline ground mass, the latter being full of granules and spicules of a bright green colour, referred with reasonable probability to manganous oxide, MnO.

Occasionally the Mn content falls to 2 per cent. It then has a grey colour, free from any green, and in samples poured into a small cast-iron mould and therefore chilled quickly, a bright blue clear selvage is present. Under the microscope this slag shows no green granules at all, and by transmitted light the blue selvage has a brown colour with marked spherulitic structure.

The old turquoise blue slags contained about 40 per cent. silica, and the modern green ones about 30 per cent.

It would appear, therefore, that the more siliceous slag was able to hold its manganese in some combination from which manganous oxide could not escape during cooling, whilst the more basic slag was only able to hold in the neighbourhood of 2 per cent. of manganese, without the latter appearing as free manganous oxide in the slag.

To what extent is it possible to reason back from the constitution of a slag as revealed by a thin slice under the microscope, to its constitution as it exists in the furnace?

In the light of the data yielded by the microscope it would appear reasonable to suppose that the more basic slag was capable at high temperatures of in some way holding in solution manganous oxide which it was unable to retain when the temperature fell and which separated out as such.

Metallurgical slags which are the fused product of the gangue of the ore and the fluxes, even in the same industry, vary widely in their composition, but the ideal blast-furnace slag must have the following properties:—

(1) It must flow freely from the tap-hole.

(2) It must not deposit accretions in the furnace.

(3) Its capacity to dissolve valuable metals must be a minimum.

(4) It must be as small in amount as possible.

(5) The fluxes entering into its composition must be obtainable at minimum cost.

(6) It must admit of fast running and good reduction of the charge.

(7) It must give a clean separation from metal, matte, or other valuable products.

(8) If, in addition, it has a value as a by-product, so much the better.

These can be more or less completely realised by slags having a pretty wide range of chemical composition, and have got away to a large extent from the notion that a blast-furnace slag is essentially one definite compound, such as a monosilicate or a bisilicate, and so orth. What is needed is a better knowledge of the complexity of compounds which we know to exist in these materials, and especially the part played in them by sulphur, dissolved gases and other minor constituents.

The slag produced at the Port Pirie (S.A.) Smelters has the following average composition:—

Silica	20.1	per cent.
Oxide of iron	28.2	,,
Oxide of manganese	3.9	,,
Lime	11.0	,,
Magnesia	2.0	,,
Alumina	6.2	,,
Oxide of zinc	22.1	,,
Sulphur	2.7	,,

At times the silica content falls as low as 17 to 18 per cent. without any deleterious effect.

Referring briefly to sinters and clinkers, these undoubtedly present a field for research. Take, for example, the sinter produced on the Dwight and Lloyd machines at a lead-smelting plant, of which the following assay is an example:—

Lead	42.5	per cent.
Silica	9.4	,,
Oxide of zinc	12.0	,,
Lime	6.1	,,
Sulphur	2.4	,,

In appearance the sinter resembles a piece of petrified sponge with a stony to

slightly glazed surface. It has evidently been fused, and owing to the method employed its appearance is homogeneous. Fusion has, however, stopped short of actual running, the material having never passed beyond the viscous stage.

As regards these sinters our knowledge is mainly empirical, and a more definite knowledge of the parts played by the different constituents of the charge and the actual sequence of chemico-physical events, from the original mixture of galena, zinc blende, gangue minerals, limestone,* sand, and granulated slag, to the finished homogeneous sinter with the great bulk of its sulphur roasted off, would be another very useful contribution to metallurgy.

The Use of Fluxes in Brass Melting, by R. Genders, M.B.E., M.Met., F.I.C., and M. A. Haughton, A.R.S.M. (Woolwich).

The methods by which brass melting and casting are carried out in this country are very similar in general features, but vary widely in detail. One striking feature is the large number of different materials used as fluxes, by which term is implied all materials added during melting which are not intended to remain in the metal in the cast form. So far as the authors are aware it is not claimed that the melting of brass is a refining operation in which elimination of impurities occurs, and it may be taken that it consists substantially in the mixing of the two metals, copper and zinc, together with whatever impurities they originally contain. Both metals tend to oxidise readily, and the total oxidation of both results ultimately in oxidation of zinc alone, since any copper oxide is reduced by zinc. The only other harmful materials appear to be the foreign matter associated with the scrap, and material of similar character derived from the walls of the crucible.

The necessity for fluxes may be therefore based on:—

(1) The avoidance of oxidation throughout all stages of the process, and

(2) the collection and elimination of foreign matter.

The first of these is accomplished to some extent during the first stages of melting (*i.e.*, the fusion of the copper and scrap) by the generation of reducing gas from added charcoal. Copper cannot be entirely deoxidised, however, by this means, and the addition of zinc inevitably results in the formation of a certain amount of zinc oxide.

Fluxes are frequently used before and after addition of the zinc, the most common being common salt, glass, borax, salt cake, silica, bone ash, plaster of Paris, boracic acid, carbonate of potash and caustic soda. The actual result of the use of these fluxes in their function as reducing agents, collectors of zinc oxide or collectors of foreign matter is known only in indefinite terms from the experience of brass melters, among whom there is considerable difference o opinion, and no quantitative data exist. The small amount of available literature on the subject deals mainly with observational work, unsnpported by experiment. A complete investigation of the action and value of fluxes presents considerable difficulty, especially in the isolation of set conditions. It is, however, suggested that results of considerable value could be obtained by determining the relative effects of the methods at present in use. The authors' experimental work has not yet reached a stage at which conclusions of immediate practical value can be drawn, and this paper is contributed with the primary object of obtaining views from as many standpoints as possible on the use of fluxes in brass melting, which, while constituting one of the largest branches of the non-ferrous metals industry, has hitherto been neglected by the scientific investigator.

Preliminary experiments indicate that when zinc oxide is formed during the melting of brass a large proportion rises quickly to the surface. The suspended oxide remaining may be largely eliminated by the stirring in of a suitable flux such as borax or glass, or by a period of rest. Possibly a further small amount may exist in a fine state of suspension, but it is questionable whether the brass is appreciably affected by its presence. Removal of final traces could only be effected by a long period of rest or the adoption of methods based on the present knowledge of colloids.

Observations during the small scale experiments suggest that in commercial brass manufacture the inclusions present in the ingot are not all derived from suspended matter in the fluid metal. Under ordinary conditions of casting, inclusions of material from the surface of the fluid metal may easily be introduced accidentally into the ingot. Oxidation of the stream of metal during pouring is another possible source of inclusions.

In general the proportion of inclusions in commercial brass, as estimated by microscopic examination, is not greater than in steel of ordinary quality. It is suggested, however, that the mechanical qualities of the metal and the quality of polished surfaces might be improved by more complete elimination of non-metallic inclusions.

(*To be continued.*)

British Empire Exhibition.

PARTICULARS OF EXHIBITS.

(*Continued from page* 316.)

THE BUXTON LIME FIRMS CO., LTD.,

who own extensive quarries in Derbyshire, have an interesting display of their products.

For centuries Buxton has been the centre of the lime burning and limestone industry in the United Kingdom, and to-day the output of the company well exceeds a million tons per annum. "Old Buxton Lime" possesses characteristics which render it the most suitable for agricultural and industrial purposes.

Of peculiar interest is a form of mechanically slaked lime, sold under the name of "Limbux." This superfine grade of hydrated lime is produced by a special process, and on account of its unvarying purity and remarkable degree of fineness, is specially suitable for water softening, concrete construction, chemical processes, and all purposes for which the highest grade of lime must be used.

Lime in its various forms has a very wide appeal, and much interesting information is to be obtained at the Buxton Lime Firm's stand.

SYNTHETIC AMMONIA & NITRATES, LTD.,

have recently completed the erection of extensive works at Billingham, Stockton-on-Tees, for the fixation of atmospheric nitrogen, and when the plant is fully working, the company will occupy an important place in the fertiliser industry.

The company was formed to take over from H.M. Government the works in course of erection for the production of nitrates for high explosives, and whilst the plant will be capable of producing large quantities of nitrogenous fertilisers in times of peace, it ensures that, should occasion demand, a ready supply of huge quantities of nitrates will be available without reliance upon foreign supplies.

Samples of anhydrous ammonia, ammonia liquor, and sulphate of ammonia produced by the company are included in their exhibit.

JAMES H. DENNIS & CO., LTD.

This firm exhibit sulphate of copper, of which they are the oldest and largest makers in the world. Their mark or brand "Macclesfield," is guaranteed 98 to 99 per cent. purity, and has been supplied for over half a century to the majority of French vine growers, and is also used extensively throughout all the vine-producing countries of the world.

"Macclesfield" sulphate of copper is supplied in size to meet the requirements of users, in the form of crystals, medium and fine powder form, also dehydrated dust. All grades are of the highest possible purity, indeed "Macclesfield" sulphate of copper is famous for its reliability and efficacy in mixtures, becoming recognised as the standard of purity and excellence.

Uses of Sulphate of Copper.—As a preventive of plant disease, especially vine, fruit and potatoes, as a weed killer, for water purification, for curing fishing nets, and as an addition to asphalt for the improvement of road material.

WHIFFEN & SONS, LTD.

Atropine, both pure and sulphate, is shown, in association with the allied alkaloids, hyoscine and hyoscyamine. The alkaloids are in the ordinary crystalline form; the sulphates in granules, convenient for dispensing small quantities, a special distinctive feature introduced with this object in view.

Hyoscine. — Hydrobromide and hydrochloride, both of exceptional purity. Specially interesting as sedatives and hynotics in cases of insomnia.

Bromides.—The firm's bromide preparations under the brand, Geo. Atkinson & Co. (branch of Whiffen & Sons, Ltd.), have an established reputation for appearance, purity and solubility, extending back over half a century.

Potassium bromide is shown in uniformly moderate size crystals, also in granules and powder.

Sodium bromide, in the form of white

anhydrous granular powder, perfectly white, and practically free from moisture.

Ammonium Bromide in dry white crytalline powder, of perfect solubility and excellent colour.

Strontium Bromide in the usual form, white transparent needle crystals, free from iron, lead and other impurities. Also exsiccated powder minus water of crystallisation.

Caffeine.—Since introduction to general therapeutic use in 1888, Whiffen's caffeine *has maintained its original unique feature* in the form of masses of unbroken acicular crystals, unrivalled for appearance and purity.

Among the salts of caffeine shown are bromide, soda benzoate, soda salicylate and valerianate.

Camphor. — Resublimed in the three forms known to the trade, viz., oldfashioned bells, tablets in varying sizes, and flowers. Our tablets are sublimed, resulting in firmness, transparency and uniformity in size. We make a speciality of "flowers," producing an article of large bulk and exceptionally white in colour.

Emetine was first made in this country by Whiffen & Sons, who, for some considerable time, were the only British makers. Formerly the name Emetine used to be applied to an impure extract containing the mixed alkaloids of ipecacuanha, but emetine as supplied by Whiffen is guaranteed pure and absolutely free from cephaeline and psychotrine.

Tbe principal salt, emetine hydrochloride, is shown. It is standard preparation for hypodermic administration in amoebic dysentery and hepatitis, and for this purpose is put up in ampoules and hypodermic tablets in doses from ¼ to 1 grain.

A later preparation, emetine-bismuth-iodide, shown in bulk and in 1 grain capsules, has been found thoroughly effective for sterilising chronic cyst carriers, and is a stable preparation containing 29 per cent. emetine.

IODIDES.—This group forms one of the staple products of the Geo. Atkinson & Co. branch, who have specialised in iodine preparations during the greater portion of a century. Samples shown include:

Iodide of Potassium in fine crystals.

Granules and powder are supplied if required.

Iodoform, in bright yellow scale crystals, powder and light precipitate.

Resublimed Iodine, in large bright crystalline scales made by an improved process to ensure exceptional purity. It will be found to test practically 100 per cent. pure iodine.

Iodide of Soda, in anhydrous granular powder, free from carbinate, sulphate or moisture.

Nicotine.—The volatile alkaloid of tobacco for horticultural purposes has been manufactured by us for many years, under supervision of H.M. Customs. Nicotine *pure, for medicinal purposes*, is also prepared, likewise salicylate of nicotine for skin disease, and tartrate of nicotine, an interesting salt.

Oils.—Expressed oil of almonds, answering all B.P. tests, has long been a leading line; also extra pale almond oil, almost colourless, and absolutely proof against rancidity.

Among the essential oils, clove oil now ranks as the most important with the firm, although at one time they distilled lavender and peppermint for the Mitcham growers.

Quinine Salts.—The manufacture of quinine salts has been carried on by the firm and its founder, the late Mr. Thomas Whiffen, for upwards of 70 years, the greatest care being bestowed upon production to meet requirements of the various official standards.

The purity and excellence of the brand are well-known. Specimens are shown of:

Quinine Alkaloid.—Chemically free from any acid, for use in special manufactures, cod liver oil preparations, and for experimental research.

Sulphate of Quinine.—The best known and popular form.

Bi-sulphate of Quinine.—Soluble in cold water or wine without addition of acid.

Muriate of Quinine.—Freely soluble and rapid of absorption.

Hydrobromide of Quinine.—Valuable in acute rheumatism. Various other salts are exhibited, such as phosphate, salicylate, glycerophosphae, and valerianate.

Salicin.—The active principle of willow bark. Discovered by Leront in 1830, and first manufactured by Thomas Whiffen in 1870. The use of salicin for rheumatism, and recently as a preventive, as well as a cure for influenza, has now become general.

For purity and whiteness, Whiffen's salicin has an established reputation, and the softness of the fine crystalline powder

renders it easily adaptable for administration in any form. Salicin is also supplied in 5-grain tablets for popular use.

Strychnine.—The manufacture of this alkaloid in a perfectly pure and highly crystallised form was commenced in 1859 by the late Thomas Whiffen, and the firm therefore claim to be the oldest British manufacturers. It was introduced on the market as "Jacob Hulle's," under which brand it is still known Previous to 1859 it was not possible to obtain a commercial sample of strychnine uncontaminated with brucine or other adulterant.

The brand, "Jacob Hulle," soon acquired that position for purity and uniformity which it has fully maintained for the past 70 years.

Strychnine is shown in bulk and in ounce bottles. bearing the commercial labels and wrappers, also packed in ounce tins, which are economical for colonial markets in respect of tariff and freight. Strychnine is likewise exhibited of a permanent pink and blue colour, as required by the Poisons Regulations in some countries.

Hulle's Soluble Strychnine is a proprietary form of the poison, which can be more conveniently employed than the alkaloid for destruction of vermin.

Salts of Strychnine, for medical use, are shown, including acetate, hydrochloride, nitrate, phosphate, sulphate, etc.

Vermilion. — Genuine quicksilver vermilion, for technical use, is not only one of the oldest, but has been one of the leading products of the Geo. Atkinson branch for very many years. The firm still have records of transactions in vermilion two centuries old.

It is made in all shades, ranging from pale orange to deep red; in fact, any tint can be matched, no matter how delicate. Specimens which have been exposed to the light for more than fifty years are shown. Apparently they are as bright and good as when first manufactured.

(*To be continued.*)

PROCEEDINGS AND NOTICES OF SOCIETIES.

THE ROYAL SOCIETY.

MAY 15.

The Bakerian Lecture, delivered by PROF. A. FOWLER, F.R.S., on *The Spectra of Silicon at Successive Stages of Ionisation.*

The present lecture may be regarded as a continuation of the Bakerian Lecture of 1914, in which it was established that series in spark spectra, though otherwise similar to arc series, are characterised by a fourfold value of the series constant N. This result was in complete agreement with Bohr's theory, according to which arc series originate in neutral atoms, and spark series in ionised atoms. The theory further suggested that atoms which had lost two electrons, or had become doubly ionised, would give series having 9N for the constant; atoms which had lost three electrons would yield series with 16N for constant, and so on.

In a search for spectra of the higher orders, one of the most promising elements appeared to be silicon, which Lockyer had already shown to be represented by different groups of lines in stars of successively higher temperatures. The spectra obtainable from this element under the action of discharges of increasing intensity have accordingly been investigated over the long range of spectrum necessary for the investigation of series relationships. The results of the inquiry are in accordance with theoretical prediction as far as the fourth spectrum, of which a preliminary account has already been communicated to the Society.

Theoretical expectations in regard to the relations between these spectra and those of elements which immediately precede silicon in the periodic table have also been realised, the necessary additional data for a full comparison being provided by Paschen's recent work on the second and third spectra of aluminium. The relations between the various spectra may conveniently be indicated as follows:—

	Doublets.	Triplets.	Doublets.	Triplets.
$n = 1$ C = N	11+, 10- Na I	Mg I 12+, 11-	Al I 13+, 12-	Si I 14+, 13-
$n = 2$ C = 4N	12+, 10- Mg II	Al II 13+, 11-	Si II 14+, 12-	
$n = 3$ C = 9N	Al III 13+, 10-	Si III 14+, 11-		
$n = 4$ C = 16N	Si IV 14+, 10-			

Series constant $= C = \dfrac{2\pi^2 e^2 m}{ch_3} \cdot \dfrac{M}{M+m} (ne)^2$.

Under each symbol the number preceding the + sign represents the nuclear charge, and that preceding the - sign the number of external electrons in addition to the one which generates the spectrum, so that in the first row the atoms as a whole are neutral. All spectra in the same vertical column have been found to be similar, but as n increases, corresponding lines are of higher frequencies, and the doublet or triplet separations are increased.

The principal numerical data, some of which are of immediate importance in connection with work on the temperatures of the hotter stars, are included in the following brief references to the four spectra of silicon.

Si I.—Theory suggests that new features will be presented by this spectrum, inasmuch as the effective electron probably traverses a 3_2 orbit; a p or P term may therefore be expected for the highest limit, and not an S term as in Mg I. The triplets are very feebly developed, there being but one representative of each of the s and d series. From analogy with other triplet spectra, however, the limit $3p_2$ may be expected to be in the neighbourhood of 85000. Six singlets which are reversed in the arc can be arranged in two series of subordinate type converging near to 60000, which may be taken as the value of 3P. If the resonance line $3p_2$ - 3P be λ3905 (ν25598), as is not improbable, the term $3p_2$ will be 85,600, in close accordance with the first estimate. Further work on this spectrum is necessary, but the resonance and first ionisation potentials may provisionally be taken as 3.2 and 10.6 volts respectively. Some of the strongest lines of the arc spectrum form two multiplets of the pp' type.

Si I.—The spectrum forms a doublet system analogous with that of Al I, and the various constituent series are well represented. Lines at λλ1533.55, 1526.83 (νν65208, 65495) form the leading pair of the sharp series, the limits of which are $3\pi_1$ = 131531, $3\pi_2$ = 131818. The resonance potential is therefore 8.09 volts and the second ionisation potential 16.27 volts. Besides the usual sets of terms, there is a double term of d type, x_1 = 76498, x_2 = 76514, which yields a strong series of fundamental type in the far ultra-violet; no corresponding terms have been noted in aluminium.

Si III.—The spectrum is of the same type as that of Al II and Mg I, consisting of triplets and singlets. The first line of the first d triplet is at λ1113.76, and that of the first s at λ997.7. The limits of the triplet series are $3p_1$ = 216879, $3p_2$ = 217142, $3p_3$ = 217273. The singlet series have not been certainly identified, but there is evidence that the resonance line 3S - $3p_2$ = ν39330, and the first principal line 3S - 3P = ν82857. If so, the resonance potential sions.
will be 4.85 volts, and the third ionisation potential 31.66 volts (3S = 256472).

Si IV.—Additional lines of the doublet system of Si IV have been photographed by Millikan in the extreme ultra-violet, but the series limits previously published are not materially modified. The resonance lines are λλ1393.9,1 402.9 (νν71740, 71280), indicating a resonance potential of 8.86 volts. The fourth ionisation potential is 44.95 volts.

The ionisation potentials, and the doublet or triplet separations, of elements in the same column of the foregoing table are more simply related than are those of elements in corn
periodic table.

CONVERSAZIONE, MAY 14.

Among the many interesting exhibits were the following:—

Sir Almroth Wright, F.R.S., Mr. A. Fleming, F.R.C.S., and Mr. L. Colbrook, M.B.: New methods for the exploration of bacterial disease. Prof. P. Groom: Cultures of dry-rot fungi. Sir Wm. Bragg: Structure of metal foils. Rothamsted Experimental Station: Effect of boron on plant growth. Mr. George H. Gabb: Portrait of Joseph Priestley in wax; silver pocket sundial of the Earl of Orrery, 1710. Prof. Bone: Bomb apparatus with petavel manometer and some pressure-time curves obtained in researches upon the *activation of* nitrogen in carbon monoxide—air explosions.

THE ROYAL SOCIETY OF ARTS.

On May 21, the Trueman Wood Lecture, entitled, *The Outlook in Chemistry,* was delivered by SIR WILLIAM J. POPE, K.B.E., D.Sc., F.R.S., Professor of Chemistry in the University of Cambridge. Sir Herbert Jackson, K.B.E., F.R.S., Vice-President of the Society, presided.

THE INSTITUTE OF PHYSICS.

The Annual General Meeting will be held on Monday, May 26, at 4.30 p.m., in the rooms of the Royal Society, Burlington House, when Sir Charles Parsons will deliver his Presidential Address.

THE CHEMICAL SOCIETY.

MAY 15.

Papers read:—

The Bromo-Derivatives of 1-Methylglyoxaline and the Constitution of "Chloroxalmethylin," by I. E. BALABAN and F. L. PYMAN.

4 : 5-*Dibromo-l-methylglyoxaline*, which results from the methylation of 4 : 5-dibromoglyoxaline, is formed in small yield by the bromination of 1-methylglyoxaline, the reduction of 2 : 4 : 5-tribromo-1-methylglyoxaline, or by the interateion of phosphorus pentabromide with dimethyloxamide.

The 4-*and*-5-*bromo*-1-*methylglyoxalines* are obtained simultaneously by methylating 4 (or 5)-bromo-glyoxaline, the 5 : 1-isomeride predominating. Distillation of the common methiodide of the two bases yields the 4 : 1 isomeride as the main product. The orientation of the bases was effected by converting the 5 : 1-isomeride into the known 4-nitro-1-metbylglyoxaline. Wallach's "chloroxalmethylin" was shown to be 5-chloro-1-methylglyoxaline.

Synthesis of Amygdalin, by R. CAMPBELL and W. N. HAWORTH.

A synthesis of amygdalin has been achieved by condensing hepta-acetyl bromo-gentiobiose with ethyl d,l-mandelate in presence of silver oxide and conversion of this compound through several stages to the natural glucoside. The product of the above condensation was d,l-hepta-acetyl amygdalinic ethyl ester, m.p. 205° and $[\alpha]_d$ -62.0, which was identical with a specimen of this substance obtained from amygdalin by esterifying and acetylating amygdalinic acid. Treatment with alcoholic ammonia led to the isolation of a mixture of d- and l-amygdalinic amide, $[\alpha]_d$ -77, and of its hepta-acetyl derivative, which was resolved, by fractional crystallisation of its addition compound with pyridine, into two stereoisomerides, m.p. 166-7° and 157-8°, having $[\alpha]_d$ -68°.6 and -49°.7 respectively. The former of these gave rise on digesting its solution in xylene with phosphorus pentoxide to needles of hepta-acetyl amygdalin m.p. 167°, having $[\alpha]_d$ -36.2°. This was identical in all respects with a product obtained by the acetylation of amygdalin and, moreover, the final stage of the removal of the acetyl groups and its conversion into natural amygdalin has already been accomplished by E. Fischer and M. Bergmann (*Ber.*, 1917, L., 1066).

Reactivity and Radiation. The Photochemical Union of Hydrogen and Sulphur, by R. G. W. NORRISH and E. K. RIDEAL.

The critical increments of eight reactions between hydrogen, sulphur, or oxygen, on the one hand, and sulphur on the other, are all multiples of a constant quantity. This suggests that activation is a quantum phenomenon. Some of the activation of sulphur molecules occurring in these reactions must be kinetic. It is, therefore, of interest to examine them photochemi-

cally, with a view to testing how far such activation as is postulated by the "radiation theory" also occurs. The gaseous reaction between hydrogen and sulphur has therefore been investigated, and has been found to be strongly catalysed by the ultra-violet light from the mercury vapour lamp, of the calculated wave length.

The ultra-violet absorption spectrum of sulphur (S_2) vapour has also been reinvestigated and the previous work of Graham confirmed, except that the point of maximum absorption is located very slightly more towards the red end of the spectrum at $\lambda = 2750$A.U. This wave length corresponds with a critical increment of 51,670 cal per gram-atom of sulphur, a number in exact agreement with that calculated from the temperaturec oefficient of the thermal gaseous reaction between hydrogen and sulphur, as required by the radiation theory.

Activation of sulphur molecules may be regarded as synonymous with the dissociation of one or more bonds, and may take place either by collision or by absorption of radiation. The quantity of energy absorbed per atom is independent of the mechanism, and is a function only of the number of valency bonds destroyed.

SOCIETY OF PUBLIC ANALYSTS AND OTHER ANALYTICAL CHEMISTS.

May 7.

Mr. G. Rudd Thompson, President, in the chair.

The following were elected members of the Society: Messrs. John Joseph Bryant, F.C.S., Edgar Wilfred Deag, Harold Wilton Hewis, B.Sc. (Lond.), A.I.C., Ernest Wilfrid Jackson, F.I.C., Thomas McGrath, Alfred Scholes, F.I.C.

Papers read:—

Estimation of Sugar in Urine by means of Fehling's Solution with Methylene Blue as Internal Indicator, by J. H. Lane, B.Sc., F.I.C., and Lewis Eynon, B.Sc., F.I.C.

The sugar in urine can be accurately estimated by means of Fehling's solutions with methylene blue as internal indicator, provided the urine be first rendered neutral to litmus. Defecation of the urine with normal lead acetate and removal of the excess of lead with potassium oxalate enables a sharper end point to be obtained. This sugar, but removes a small amount of reducing non-sugar substances (equivalent to about 0.02 to 0.03 per cent. of dextrose). The results obtained by the method agree closely with those given by Gerrard's cyano-cupric method, but are considerably lower than those given by Pavy's method, this being attributed to non-sugar substances being estimated in that method. Methylene blue can also be used as an internal indicator with Pavy's or with Benedict's solution.

Simple Forms of Hydrogen Electrode, by J. J. Considene.

The construction and method of using three simple forms of hydrogen electrode which can be readily made from apparatus used in every laboratory, was given. One of these was an electrode for general use; the second a "micro" modification of this, and the third a modification of the capillary form of electrode, which has been found useful for fluids of low conductivity.

Note on the Recognition of Hydrogenated Oils, by K. A. Williams, B.Sc., and E. R. Bolton, F.I.C.

During the hydrogenation of oils iso-oleic acid is formed. This acid does not occur in nature; it is an isomer of oleic acid, has an iodine value of 90, and is characterised by the insolubility of its lead salt in organic solvents, in this respect resembling the unsaturated ones. The authors suggest that for tbe detection of hydrogenated fats the iso-oleic acid content of the fat should be determined. This is done by performing the ordinary lead salt ether separation of the fatty acids (details of which are given), by which the iso-oleic acid is separated from all other unsaturated acids, and appears in the fraction containing saturated acids; in this it is estimated from the iodine value. The effect of the use of various solvents for the separation is recorded, methylated ether or alcohol being recommended. Figures are given which show the amount of iso-oleic acid to be expected in fats hydrogenated to various degrees, and examples of the application of the method are discussed.

Notes on the Analyses of Milk Powders and Condensed Milks, by Dan W. Steuart, B.Sc.

The citric acid content of full cream milk

skim milk powders 1.55 per cent., equal to about 0.144 per cent. of anhydrous citric acid in the original milk. The citric acid content of pure milk products is equal to about one-fifth of the ash. Analyses of milk powders and condensed milks were given. Lactose is estimated by the reduction method of Lane and Eynon (using methylene blue as an internal indicator), after removing the protein and lime.

The London County Council have addressed a letter to the Council of the City and Guilds of London Institute, in which it is indicated that the L.C.C. does not feel justified in continuing its grant towards the maintenance of the College. Under these circumstances there is no other course open to the Council of the Institute but to make arrangements to close down Finsbury Technical College in July, 1926, or possibly before that date.

GENERAL NOTES.

GAS EXAMINATION.

DEPUTATION TO THE BOARD OF TRADE.

In the unavoidable absence of the President of the Board, Mr. Alexander (Parliamentary Secretary) received a deputation from the Institutes of Chemistry and Physics at the Board of Trade on Thursday, May 1, in connection with the qualifications of gas examiners appointed by local authorities for the purpose of protecting the interests of the public users of gas supplies.

The deputation was introduced by Major Church, Parliamentary Private Secretary, and consisted of Sir Richard Gregory, Sir Herbert Jackson, Sir Charles Parsons, Mr. E. M. Hawkins, Mr. G. Nevill Huntly, Professor Eccles, and the officers of the Institutes of Chemistry and Physics.

Sir Richard Gregory, in opening, stated that by the Gas Regulations Act, 1920, the price of gas was made to bear a definite relation to the quality, and not only to the quantity of gas purchased. For this purpose the Gas Regulations Act required the appointment of a competent and impartial person to be a gas examiner. It was necessary to emphasise the importance of defining the phrase "competent and impartial person," as the section of the Act which relates to the powers of the gas referees did not require them to define competency, and there was no reference in any part of the Act to such a definition. The result was that the practice of local authorities with regard to the appointment of gas examiners varied considerably.

As a general rule, the authorities in the Metropolitan area, and of large provincial cities, secured for their gas examiners highly competent persons; but small local authorities, particularly in rural areas, regarded with some disfavour expenditure on this kind of service: the protection to the public from small local gas companies often not too efficiently directed, was correspondingly reduced. He claimed that the gas examiner should be a person of similar standing to a public analyst, over whose appointment the Ministry of Health could exercise a veto, and suggested that the Board of Trade should secure this right under statutory powers. In his opinion the higher the standing of the gas examiner and the stronger the corporate body to which he belonged, the more adequately were the public safeguarded.

Sir Herbert Jackson pointed out that the chief concern of the Institute of Chemistry, the Institute of Physics, and similar professional bodies in matters of this kind was to safeguard the interests of the public. Properly qualified professional men had behind them the traditions and status of their institutions, and were sensible of the grave responsibilities of their duties, and answerable to their professional institutions for their conduct.

Interesting examples were given by Mr. Hawkins and Mr. Huntly of the manner in which incompetent gas examiners might fail to detect irregularities by which the public might suffer loss.

Sir Charles Parsons pointed out that in the case of gas examination, no simple fool-proof instruments existed, as in the case of the measurement of electrical units. It was not until he was associated with Sir George Beilby at the Fuel Research Board that he realised how difficult was the task of carrying out the test with gas calorimeters; and it was only recently that he had been made acquainted with the fact that in some places incompetent people were being employed as gas examiners. Like the other speakers, he insisted that

gas examiners should be persons of high professional qualifications and standing.

Mr. Marlow, Assistant Secretary of the Institute of Chemistry, in summing up, said that the case of the Institutes was that the word "competence" in the Act required definition. The point would be met if the Board secured the necessary statutory powers to issue orders defining "competence."

In reply, Mr. Alexander said that the Board were most anxious to protect the public, and that the representations of the deputation would receive the most careful consideration of the President and the Officers of the Board. The changes in the method of appointment of gas examiners suggested by the deputation indicated the necessity for statutory powers being granted by Parliament. He was certainly not in the position to promise legislation this session, as there were many important and overdue Bills on the stocks. He pointed out also that the Board must work in harmony with the local authorities, and that in the event of legislation being contemplated the local authorities would have to be consulted.

The deputation thanked Mr. Alexander for their reception.

CORRESPONDENCE.

To the Editors of THE CHEMICAL NEWS.

SIRS,—I have been trying for some time to obtain details of a process for etching celluloid from designs on copper plates. I should be grateful if any of your readers could inform me where I can obtain information on this subject.—Yours, &c.,

G. O. SHEFFIELD.

16, *Lowther Road, Brighton.*
April 30, 1924.

NOTICES OF BOOKS.

Fünf Vorträge, von FRITZ HABER. Pp. 92. Berlin: Verlag von J. Springer. 1924.

These five discourses, published in book form, were delivered in 1920-23 by Prof. Haber, who dedicates them to Prof. Willstätter. All were of great importance and interest, as the following titles show: The Synthesis of Ammonia; Chemistry in the War; The Age of Chemistry; New Procedures; and The History of Gas-Warfare.

The first one (of great interest to chemists), on the preparation of ammonia from its constituents, was delivered at Stockholm in 1920, in acknowledgement of the Nobel Prize.

The accomplishments of German chemists in the war are portrayed in the second, and the third deals with the problems and achievements of applied science. The fourth is concerned with the industrial lessons of the war, and the final one gives the German point of view with regard to gas-warfare.

The volume is well worthy of the notice of English chemists.

Osmics—The Science of Smell, by JOHN H. KENNETH, M.A. 1924. Edinburgh: Messrs. Oliver & Boyd, Tweeddale Court. 2s.

The first number of *Osmics*, containing an introduction and 500 bibliographical references, was issued in 1922. The issue of a second number is ventured in the hope that this bibliography of the literature on the organs and sense of smell, and on odorous substances, will facilitate and encourage research into the many problems of osmics.

Annual Reports of the Progress of Applied Chemistry, 1923, issued by the SOCIETY OF CHEMICAL INDUSTRY. Pp. 618. Vol. VIII. Society of Chemical Industry, Central House, 46-47, Finsbury Square, E.C.2.

The Annual Reports on the progress of applied chemistry, issued by the Society of Chemical Industry, form a comprehensive survey of the advances made during the past year. Each section dealing with one of the many branches of chemical manufacture and technology, has been written by a specialist in that field.

Plant and machinery, fuel, destructive distillation, dyes, fibres, textiles and cellulose, bleaching, glass, the metals, electrochemistry; oils, fats and waxes; paints varnishes and resins; rubber; leather and glue, soils and fertilisers; sugars, starches and gums; fermentation industries; sanitation; explosives; and the various purely chemical manufactures, are all considered with regard to the progress made in the last year.

It will be observed that there is no sec

tion dealing with photography and photographic materials in this volume. No reason is given for this omission, which is difficult to understand in view of the considerable work now being done in that branch of applied science.

Some of the sections have been very well written, but in others results of important researches have been omitted.

For what the book contains it is exceedingly valuable, and should be read by all technical and works chemists anxious to keep themselves informed of the latest methods and practice.

Treatise on General and Industrial Chemistry, by DR. ETTORE MOLINARI. Translated by T. H. POPE, B.Sc., A.C.G.I., F.I.C. Part II., with 303 illustrations. Pp. VIII. + 440. Second English Edition, 1923. London: J. & A. Churchill. 30s. net.

The volume under review completes the work on chemistry treated from an industrial standpoint. The treatment of the material follows the same lines as those employed in the first edition, which appeared in 1913, with the result that the reader will find much of the valuable information collected together in the form of foot-notes, many of which are very long and may even cover an entire field of industrial enterprise. This lack of continuity will be readily borne by the technical chemist who is on the look-out for new ideas, and from the student's point of view the book has the double advantage of utilising the recognised academic framework for the unfolding of the story, so that the treatment of a manufacturing process becomes merely an excursion from the familiar scientific pathway of organic chemistry, and of drawing attention to the economic side of chemical manufacture in a way which is foreign to most of the text-books which are placed in the hands of students. The statistics, as given, however, suffer from two drawbacks: firstly, the book was originally written in Italian, and therefore the figures relate to the economic position in a foreign country; and secondly, on account of the fact that although the book has been translated from the Italian into the English language, yet the system of values and weights recorded is not that with which an average English student is likely to be familiar.

This volume, when compared with the first edition, shows that the oil industry has been extensively revised in order to include the comparatively recent achievements in the hardening of oils by the hydrogenation process. The synthetic dyestuff industry is dealt with in as great detail as previously, but it is unfortunate that many loose statements and errors appearing in the first edition remain unaltered. Of the information new to this edition which is incorrect, it should be pointed out that Adamsite or D.M.—a gas used in the late war—is confused with diphenylchlor arsine. Adamsite, or D.M., was diphenylamine arsenious chloride, which is the compound formulated, whereas diphenylchlorarsine was also used as a "poison gas" and was represented by the letters D.A., and has the formula $(C_6H_5)_2$ As Cl.

The division of the organic section into two parts appears a doubtful improvement, especially as the division does not occur at any conventional halting place. Further, the enlargement appears to have been rendered necessary, not on account of the amount of fresh material incorporated, but by the use of larger type for some of the foot-notes and the desire of the publishers to include an abridged catalogue of nearly thirty pages giving particulars of their wares—an objectionable practice. However, we can certainly congratulate Prof. Molinari on the production of a work which is certain to be as much sought after by both present and future technical chemists as its predecessor has been. F.L.S.

FORCES ROUND ATOMIC NUCLEI.

In the *Proceedings of the Royal Society*, 1924, A, 105, p. 434, E. S. Bieler gives a paper on "The Large-Angle Scattering of α-Particles by Light Nuclei." It appears from this investigation that the inverse-square law of electrostatic force round the nucleus of the atom does not hold very close thereto. Bieler finds that the inverse-square law of distance breaks down at short distances from the nucleus, and that the law followed there approximately is the *inverse fourth-power law.*

In point of fact there is an additional force that is *attractive* towards the α-particle, and it is this force that varies more rapidly than the electrostatic repulsion towards the α-particle. There is therefore a particular distance where both forces acting jointly on the α-particle would vanish; this

radial distance from the centre of an aluminium nucleus (one containing 27 protons and 14 electrons) being 3.44×10^{-13} cm. Below this distance—which might mean within the nucleus itself—the attractive force for the α-particle will be stronger than the repulsive force, while beyond the distance the repulsive force will predominate.

It will be remembered that Sir E. Rutherford referred to Bieler's work (one is here tempted to say Bieler's law) in his recent discourse on the atom at the Royal Institution, April 4, 1924. It will also be remembered that Sir J. J. Thomson has discussed the problem of a change of force round the nucleus (see *The Chemical News*, 1924, current volume, pp. 129, 130).

This field of research strikes at the very root of things, and its importance to science cannot be underestimated.

BLUE SKY AND THE SPECTRUM OF THE AURORA.

Readers of *The Chemical News* will remember that Mr. Loring gave prominence to Vegard's theory of the blue sky and the origin of the auroral spectrum in the part of a paper which appeared in these columns in the issue of December 7 last. We are pleased to record here that Prof. Vegard, in a communication before the Academy of Sciences, Paris, announces that he has succeeded in imitating the auroral spectrum by bombarding a sheet or surface of frozen nitrogen (frozen on a copper plate by liquid hydrogen as the cooling agent) with cathode rays. This has far-reaching consequences, as it completely confirms Vegard's view that the blueness of the sky is due to frozen particles of nitrogen in the upper atmosphere, the same particles giving rise to the Northern-light spectrum observed.

This means that rays corresponding to cathode rays are emitted by the sun. The magnetic field of the earth and the electric charges on these particles account for the localisation of the phenomena.

The light from meteors entering the earth's atmosphere is also explained in part by this theory. See, in this connection, *The Chemical News*, February 22, 1924, p. 122, where a table of the after-glow lines due to nitrogen is given. The line 3101.9 should read 3801.9 in the column of lines due to Fowler and Strutt.

Thus it will be seen that we are beginning to know something definite about phenomena which have puzzled scientists for a

BOOKS RECEIVED.

Bibliographie de la Relativité, par M. & MME. MAURICE LECAT. Pp. 290 + 47. 1924. Brussels: M. Maurice Lamertin, Rue Condenberg, 58-62.

Reports of the Progress of Applied Chemistry, issued by the SOCIETY OF CHEMICAL INDUSTRY. Pp. 618. Vol. VIII. 1923. Society of Chemical Industry, Central House, 46-47, Finsbury Square, E.C.2.

Spectroscopy, by E. C. C. BALY, C.B.E., M.Sc., F.R.S. Pp. XI. + 298. Vol. 1, 3rd Edition, 1924. Messrs. Longmans, Green & Co., 39, Paternoster Row, E.C.4. 14s. net.

The Manufacture of Sulphuric Acid, by WILFRID WYLD, ESQ. Pp. XII. + 424. Vol. II., 1924. Messrs. Gurney & Jackson, 33, Paternoster Row, E.C.4. 31s. 6d. net.

Das Springluftverfahren, von BERGASSESSOR LEOPOLD LISSE. Pp. VII. + 109. 1924. Messrs. Julius Springer, Berlin. $1.20.

PUBLICATIONS RECEIVED.

The third Sorby lecture, entitled *Present and Future Problems of Metallurgy*, by DR. W. ROSENHAIN, F.R.S., on Nov. 9, 1923, has just been reprinted and issued at 1s.

New Patents.

THIS list is specially compiled for *The Chemical News* by Messrs. Rayner & Co., Registered Patent Agents, of 5, Chancery Lane, London, from whom all information relating to Patents, Trade Marks, and Designs can be obtained gratuitously.

Latest Patent Applications.

10022—Bellis Heat Treating Co.—Fused eutectic salt baths. April 22.

10100—Dubois, A.—Production of hydrocyanic acid. April 23.

10105—Maimeri, C.—Preparation of diethyl sulphate from ethylene. April 23.

9908—Simon, Ltd., H.—Means for detecting chlorine, etc. April 22.

Specifications Published this Week.

213991—Howards & Sons, Ltd., and Blagden, J. W.—Making synthetic menthol.

Abstract Published this Week.

212280—Manures. — Visser, C. K., Julianalaan, Delft, Holland.

A fertiliser is made by adding insoluble neutral salts to activated sewage sludge and de-watering the mixture by filtration, as by means of filter-presses. Salts of lime and magnesium, for example, chalk, Thomas meal or magnesite, may be used.

Messrs. Rayner & Co. will obtain printed copies of the published specification and abstract only, and forward on post free for the price of 1s. 6d

THE CHEMICAL NEWS,

VOL. CXXVIII. No. 3346.

THE HAFNIUM CONTENT OF ZIRCONIUM ORES.

By George Hevesy and Valdemar Thal Jantzen.

In the December, 1923, issue of the *Journal of the Chemical Society*, we communicated the results of our investigations on the hafnium content of 32 zirconium ores. Since that time we have analysed numerous other zirconium minerals, some of them having a very low zirconium content. Our aim in so doing was, first, to ascertain whether hafnium was also present in these minerals, and secondly, to find out whether in any of these minerals the ratio of hafnium to zirconium is higher than in the minerals hitherto investigated. The results of this work are communicated below.

Analyses of Zirconium Minerals (Values in Per Cent.).

Mineral	ZrO_2	HfO_2
(a) Blue transparent Zircon from Siam	60-67	3,5
(b) Malacon from Hitterö[1]	62,8*	5
(c) Malacon from Madagascar[2]	—	7
(d) Zircelite from Brazil[3]	51,7	1,2
(e) Polymignite[4] from Fredriksvärn	28,7	0,9
(f) Elpidite from Narsarsuk[5]	20,1	0,4
(g) Brown Eudialyte from Narsarsuk	12-16	0,6
(h) Red Eudialyte from Narsarsuk[6]	12-16	0,2
(i) Pyrochlore from Alnö[7]	2,8	ca.0,1
(j) Thortveitite from Unneland, Norway	0,8	1,1
(k) Thortveitite from Iveland, Norway	1,2	2,0
(l) Thorteveitite from Befanamos, Madagascar	2,2	1,8
(m) Thorteveitite from Befanamo, Madagascar	2,0	3,2

Samples (l) and (m) were presented by Professor Lacroix in Paris to the Mineralogical Museum of Christiania, and kindly lent us by Professors Goldschmidt and Schetelig.

A complete analysis of the Befanamo (Madagascar) thortveitite was carried out by Ch. Boulanger and G. Urbain (*C.R.*, 1922, CLXXIV., 1442). They found the following average values:—

SiO_2	Sc_2O_3	Y,Yb,Lu	ZrO_2	Al_2O_3	Fe_2O_3
44.1	41.9	0.5	8.4	3.3	2.0

However, no indication of the presence of zirconium was formerly found in the Norwegian specimens (*Comp.* J. Schetelig, *l.c.*).[8]. As seen from the above figures, every sample of thorteveitite investigated by us contains zirconium, and in three cases from four is the ratio HfO_2/ZrO_2 even greater than 1, so that this is the first mineral we have investigated which exhibits a higher content of hafnium than of zirconium.

It is a very interesting phenomenon that certain widely distributed but relatively rare elements such as rubidium, cæsium, scandium, and so on, are occasionally found as the chief constituent of a few, and sometimes only of one ore. We have only very vague ideas as to how the concentration of these elements in particular minerals has taken place. Research performed during the last few years in connection with the discovery of isotopes has brought to light some interesting information bearing on the phenomenon in point. The fact that for example chlorine, no matter from what source it may be derived, always exhibits the same atomic weight, *i.e.*, that the "mixed element," chlorine, always contains the same admixture of Cl^{35} and Cl^{37}, can hardly be accounted for otherwise than by assuming that in the material of the original gaseo-liquid earth, a homogeneous mixture of the two chlorines was present, and that all the numerous geo-chemical changes which have taken place during and since the solidification of the earth's crust have had no influence on this composition. The constancy of the atomic weight of "mixed elements" of different origin is in reality more powerful evidence of the chemical inseparability of isotopes than the combined evidence of our laboratory experiments.

It is reasonable to suppose that, as well as chlorine, the other elements were also mixed in a constant ratio in the gaseo-liquid earth material, this ratio being for hafnium and zirconium about 1/30. The fact that a ratio not very different from

that mentioned is found in most zirconium minerals can be regarded as very strong proof of the very great chemical similarity of hafnium and zirconium. A very appreciable alteration of this ratio could only be brought about by very special conditions in regard to time of crystallisation, stress, or shearing pressure, temperature, presence of other elements, etc. That such special conditions are possible is evidenced by the fact of the occurrence of the unique ores already mentioned, in which rubidium, cæsium, scandium, ruthenium, etc., are found as chief constituent. It thus seemed reasonable to investigate such minerals as contain zirconium, of which thortveitite is an example, with a view to finding one with an excessive Hf/Zr ratio.

It was pointed out in our previous paper that in several cases ores possessing a high Hf/Zr ratio are much more radioactive than the more abundant and but feebly radioactive zircons. This is in conformity with the views expressed above,[9] for the radioactivity of these minerals is due to uranium and thorium oxides present in them as accessory constituents. We can often interpret the presence of relatively large amounts of these compounds in a mineral as an indication of comparatively extensive transformations which the mineral, or, in more precise terms, its contained admixture of zirconium and hafnium, has undergone. Such transformations render possible a marked alteration of the value of the Hf/Zr ratio, as compared with that originally present.

Institute of Theoretical Physics,
The University, Copenhagen.

References:—

[1] *Comp.* St. Kitchen and Winterson, *T. Chem. Soc.*, 1889, LXXXIX., 1568. (*The particularly high hafnium content of malacon had already been shown very soon after the discovery of hafnium by Goldschmidt and Thomasen*) (*Norsk geologisk Tidsskrift*, 1923, VII., 61.)

[3] *Comp.* G. T. Prior, *Min. Mag.*, 1897, XI., 180.

[4] *Comp.* C. W. Blomstrand and W. C. Brögger, *Zeit. f. Kryst.*, 1890, XVI., 691.

[5] *Comp.* G. Lindstrom, *Geol. Fören. Föv.*, 1894, XVI., 8307.

[6] *In the "Proc. Chem. Soc.," l.c., an analysis of an eudialyte (also from Greenland) was given, the hafnium content of which was only 0.19 per cent. The two above samples represent the richest occurrences in Greenland; they were collected by Professor O. Böggild, by whose kindness it came into our possession.*

[7] *Comp.* P. J. Holmquist, *Geol. Föv. Förh.*, 1893, XV., 588.

[8] *According to a personal statement by Professor Schetelig, Goldschmidt and Thomasen recently found by X-ray analysis from Norwegian thortveitite the presence of zirconium, and their result was confirmed by optical spectroscopic examination.*

[9] *Considerations of this kind also explain the fact recently emphasised by Ed. and G. Urbain* (*C.R.*, 1924, CLXXVIII., 265), *that a higher Hf/Zr ratio in minerals in some cases corresponds to a higher content of yttrium and elements of the rare earth group present in the ore. From Urbain's determinations of the atomic weight of zirconium extracted from various minerals it can be inferred that these extracts contained a quantity of hafnium in some cases amounting to 5 per cent. Very soon after the discovery of hafnium, Goldschmidt and Thomasen (l.c.), having found that alvite and malacon provide an especially abundant source of hafnium, they pointed out already that such "metamict metamorphosed" minerals are often characterised by the presence of a large amount of the rare earth elements. Both the radioactivity of the mineral and its content of yttria earth give only very rough indications of the Hf/Zr ratio present. For example, thortveitite from Madagascar has, according to Boulanger and Urbain (l.c.) only a very slight content of yttria earth, and shows, in spite of this, the highest Hf/Zr ratio ascertained by us.*

THE CONSTITUTION OF THE THIONIC ACIDS.

By I. Vogel.

(*Concluded from Page 327.*)

The formulæ of the acids are accordingly

$H.SO_2.O$	$H.S.SO_2.O$	$H.S_2.SO_2.O$
|	|	|
$HO.SO_2.S$	$HO.SO_2.S$	$HO.SO_2.S$
Trithionic acid	Tetrathionic acid	Pentathionic acid

The above formulæ receive further support from the following considerations. In penta-thionates two atoms of sulphur occupy positions essentially different from those of the other three. These can be removed either successively or together, and the residue of the molecule can exist either alone or can reunite with sulphur to produce pentathionate; this is readily accounted for by the above formula. The following may be taken as an *experimentum crucis* to decide between the Mendeléeff-Blomstrand, Michaelis and Debus formulæ. According to the Mendeléeff-Blomstrand and Michaelis formulæ, potassium pentathionate may be formulated $S_3(SO_3K)_2$; this should react with bromine according to the following equation:

$$S_3(SO_3K)_2 + Br_2 + 2H_2O = S_3 + 2KBr + 2H_2SO_4,$$

liberating three atoms of sulphur, whereas the Debus formula requires that two atoms of sulphur be liberated. The experiment was performed by Debus, and the reaction found to take place thus:

$$2K_2S_5O_6.3H_2O + 8Br_2 + 9H_2O = 4KBr + 4S + 6H_2SO_4 + 12HBr.$$

This indicates the correctness of the Debus formula.

H. Hertlein (*Z. Phys. Chem.*, 1896, XIX., 286) carried out a physico-chemical investigation on the thionic acids and their salts. Only his most important experiments will be considered. He first investigated the conductivity of aqueous salt solutions.

Most of his measurements are hardly satisfactory, as the following example of some of his results indicates. The calculation of the mobility of the dithionate ion, S_2O_6'', from measurements of the conductivity at infinite dilutions of various salts, gave the following results:—

	$Na_2S_2O_6$	K_2S_{26}	BaS_2O_6	$H_2S_2O_6$
$\Delta\infty$	135.6	154.1	139.5	166.0
	-Na 49.2	-K 70.6	-Ba 64.0	-H 69.5
S_2O_6''	86.4	83.5	75.5	96.5

Thus the mobility of the S_2O_6'' ion varied between 75.5 and 96.5. Conductivity measurements of the free acids pointed to the latter being very strong, *e.g.*, at a dilution of 43.18 litres—the degrees of dissociation of dithionic and tetrathionic acids were respectively 0.896 and 0.92.

Refractivity measurements of solutions of the various salts were carried out with the Pulfrich refractometer; some of the results are given below. It will be observed that there is an approximately constant difference of about 14 units between salts differing by one atom of sulphur. This corresponds with the refractivity of divalent sulphur (14.4), and it was therefore concluded that sulphur is singly linked with itself in the polythionates.

Salt.	Refractivity.	
$K_2S_2O_6$	50.24	
		14.45
$K_2S_3O_6$	64.69	
		14.71
$K_2S_4O_6$	79.40	
		15.52
$K_2S_5O_6$	94.92	

In order to decide whether the metal was directly attached to sulphur, as in Debus' formula, or to oxygen, as in the Mendeléeff-Blomstrand formula, some electromotive force measurements were carried out. It is a well known fact that when a metal is directly attached to sulphur there is a great tendency for complex ion formation with mercury or silver salts; this can readily be detected by e.m.f. measurements. A specific example where complex ion formation is known to occur, investigated by Hertlein, is the following: — The e.m.f. of Ag/.0022 N $AgNO_3$ measured against a standard calomel electrode was found to be -0.92 volts; on the addition of N/2 $K_2S_2O_3$ the complex salt $KAgS_2O_3$, giving rise to the ion, AgS_2O_3', was formed, and the e.m.f. rose to -0.23 volts. The following results were obtained, employing equivalent solutions of the various salts:

	Dilution (litres).	E.M.F. (volts).
$K_2S_2O_6$	20	0.90
$K_2S_3O_6$	20	0.79
$K_2S_4O_6$	20	0.89
$K_2S_5O_6$	20	0.88

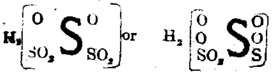
Since there was only a slight change in the e.m.f., Hertlein concluded that no complex ion formation occurred, and therefore the metal was not directly attached to sulphur, as in Debus' formulæ. He con-

cludes that his results support the Mendeléeff-Blomstrand formula for the thionic acids. Apparently he did not know of Michaelis' work, for the results equally support the formulæ proposed by Michaelis.

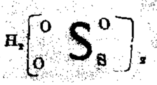
Raschig (*Z. angew. Chem.*, 1920, p. 261) emphasised what had already been pointed out by Debus, that the so-called dithionic differs very greatly in properties from the other thionic acids, *e.g.*, dithionic acid is produced by the oxidation of sulphur dioxide by pyrolusite, or potassium permanganate, whilst the other thionic acids are produced by the reduction of sulphur dioxide by sulphuretted hydrogen; also dithionic acid is comparatively stable and very slowly decomposed by boiling with concentrated hydrochloric acid, whilst the remaining thionic acids are unstable and are readily decomposed under the same circumstances. It seems that the constitution of dithionic acid must differ from that of tri-, tetra- and penta-thionic acids.

Riesenfeld and Feld (*Z. Anorg. Chem.*, 1921, CXIX., 225), a year later, pointed out, as Raschig had done previously, that dithionic acid is not a true thionic acid; they suggest the name hyposulphuric acid —a term first employed by Welter and Gay Lussac, the discoverers of the acid. In the course of their paper they make the following significant statement:—" Da die Wernersche Theorie alle früheren Vorstellungen von der Konstitution dieser Verbindungen hinfällig macht, so sei die angeblichen Konstitutionbeweise und die verschiedenen Auffassungen von der Konstitution der Polythionsäuren hier nicht weiter eingegangen." They are, however, doubtful as to the exact co-ordination number of the sulphur, whether 4 or 6, and suggest the following formulæ:—

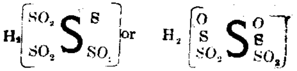
Tetrathionic acid:



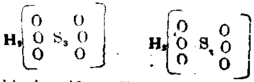
Pentathionic acid:



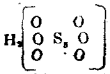
Trithionic acid:



Riesenfeld and Feld also suggest the following formulæ, assuming the existence of groups of the general formula S_x and a co-ordination number of 6:—



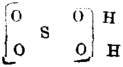
Trithionic acid. Tetrathionic acid.



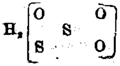
Pentathionic acid.

No evidence is given in support of any of these formulæ.

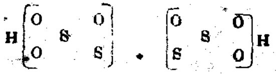
Martin and Metz (*Z. Anorg. Chem.*, 1923, CXXVII., 82) overcame the difficulty of determining the co-ordination number in the following manner. The formula for thiosulphuric acid is given as



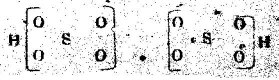
this indicates a co-ordination number of four and a valency of 6 for the central S atom, and 2 for the "peripheral" S atoms (ions). Tetrathionates are easily prepared from iodine and thiosulphates, hence the formula for tetrathionic acid is:—



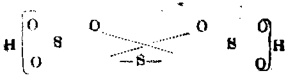
or more clearly:



Tetrathionic acid thus formulated corresponds to persulphuric acid;

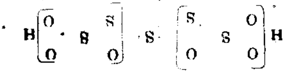


hence, if the formulæ are correct, persulphuric acid should have similar properties to tetrathionic acid. This is actually the case. Persulphuric acid readily loses oxygen, *i.e.*, is an oxidising agent; tetrathionic acid readily loses sulphur, *i.e.*, is a "sulphurising" agent, *e.g.*, it converts a sulphite into a thiosulphate, and cyanide into a thiocyanate. By loss of one atom of sulphur, potassium tetrathionate passes into the trithionate, and also, by the addition of a sulphur atom, the pentathionate is formed. This and many other facts indicate that there is a genetic relation between the three polythionic acids. Trithionic acid is



(the central S atom has still a co-ordination number of four),

whilst pentathionic acid is:—



These formulæ explain the ready loss of a sulphur atom from pentathionates, the interconversion of the polythionic acids, the presence of divalent sulphur, their strong acidity, the non-complex ion formation, and, in fact, all Hertlein's measurements. It may well be stated that these are the only formulæ for the thionic acids which explain all the facts known at present.

In conclusion, the author wishes to express his best thanks to Professor J. R. Partington, for the interest he has taken in this paper.

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THE CONSTITUTION OF THE THIONIC ACIDS.

ERRATA.

"CHEMICAL NEWS," DATED MAY 23.

Page 325, line 4, column 1: for "(1808)" read "(1810)." Line 15, column 2: for "(*Ann. Chim. et Phys.*, 1826, X., 813)" read "(*Ann. Chim. et Phys.*, 1819, X., 318)." Line 16, column 2: for "in 1826" read "in 1819." Page 326, line 8 from the bottom, column 2: for "Recent work" read "Recent research."

British Empire Exhibition.

PARTICULARS OF EXHIBITS.

(*Continued from Page* 333.)

MAY & BAKER, LIMITED.

This exhibit covers a wide range of chemicals, both for medicinal and industrial purposes. It includes products as far apart as Seidlitz Powder, the old-fashioned household remedy, and Novarsenobillon, one of the most efficient products of modern scientific research. As these examples indicate, the activities of this firm have kept pace with current requirements.

Medical practice now demands precise and scientific weapons for combating disease. The firm have played a considerable part in satisfying this demand, and manufacture, on a large scale, various modern remedies. These include antisyphilitic preparations, hypnotics, local anæsthetics, and diuretics.

Chemicals for general medical and industrial purposes are represented by a wide selection of organic and inorganic compounds, alkaloids, resins, chloroform, ether, etc.

Prominent in the exhibit may be mentioned the following:—

Novarsenobillon ("914").—This is the most widely used of the arsenobenzol compounds, and is unsurpassed in therapeutic activity and low toxicity, for all forms of syphilis. Tested biologically by the Medical Research Council and approved by the Ministry of Health.

Arseno-Argenticum (Sodium Silver Arsenobillon).—For use in the treatment of syphilis in its later stages and its nervous manifestations. Tested biologically by the Medical Research Council and approved by the Ministry of Health.

Luatol (Bismuthyltartrate of Sodium and Potassium).—Good results have been obtained in cases of syphilis resistant to, or intolerant of, arsenobenzol compounds. Issued in two forms—ampoules of solution in water, and ampoules of suspension in oil.

Rubyl (Quinine Bismuth Iodide).—For intramuscular injection in the treatment of syphilis. In ampoules containing a suspension in oil.

Soneryl.—A hypnotic and analgesic of remarkable power and freedom from injurious effects. Of wide application on account of its analgesic properties.

Planadalin.—Identical with adalin. An effective and safe sedative and hypnotic.

Bismuth Salts.—The firm's products are unsurpassed in appearance and purity. Specially light forms of the carbonate and subnitrate are manuactured for convenience in dispensing.

Mercurials.—A wide selection of these is shown, the firm being the largest British manufacturers. Three examples calling for special notice are:—

Mercury Bichloride, which can be supplied in small granules which prevent the formation of hard lumps which so often occur when the powder is kept in stock for any length of time.

Mercury Oxide Yellow.—A specially light form has recently been introduced which has twice the bulk of any other brand at present on the market; this should appeal to all manufacturers of anti-fouling compositions.

Mercury Oxide Red.—In an exceedingly fine state of division, entirely free from nitrates, and with an increased covering power. Compared with the old type of levigated oxide, it should also demand the attention of the manufacturers of anti-fouling paints.

Ether.—This is manufactured both for industrial and medicinal purposes. Baker's anæsthetic ether is unsurpassed for purity and effectiveness; it was supplied to the Army during the war, having to pass the most stringent tests; it is still supplied to the War Office, and is in sole use in many hospitals.

Chloroform.—Made from acetone; complies with all the requirements of the Pharmacopœia, and is guaranteed equal for anæsthetic purposes to the much more expensive product made from rectified spirit.

Camphor.—The high quality of the camphor sublimed by this firm is well known. The flowers are in the form of a very dry and fine crystalline powder, entirely free from oil and moisture. The tablets are prepared by a special sublimation process, ensuring absolute purity and transparency. The wrapped tablets can be stocked indefinitely without losing their weight or bright appearance.

Alkaloids.—Prominent among these is strychnine, of which a fine selection of the salts is exhibited, together with the official source, nux vomica seeds. Other alkaloids exhibited are salts of arecoline and yohimbine.

The following may also be mentioned:—

Acid molybdic and ammonium molybdate, used for steel testing; barium sulphate, extra pure, for X-ray diagnosis, entirely free from all soluble barium salts; lead arsenate powder, extra light and fine, specially adapted for horticultural purposes; potassium cyanide, of various strengths from 25 per cent. to 95 per cent., also the double salt, 98-100 per cent., containing 25 per cent. potash base; lithium salts; Seidlitz powder and Rochelle salts; Guaiacum jalap, and Scammony resins.

MURGATROYD'S SALT WORKS, LTD.,

One of the old established firms carrying on the ancient British industry of salt-making at Middlewich, Cheshire (but not by the methods of the Ancient Britons), make a comprehensive exhibit of every grade of salt ranging from the coarse salt used for curing fish down to fine salt analytically pure.

The company obtains its raw material from the far-famed Cheshire brine fields, which, on account of the high quality of the brine, have been since Roman times the main source for the production of salt in this country.

Recently, owing to the depreciated exchanges, some quantities of German salt found their way into this country, and there is a certain amount of Spanish solar salt used in the coast towns for fish curing. With these exceptions the British market has always been supplied by the British salt manufacturers, and very large quantities of salt made from Cheshire brine have been and are still being exported to all parts of the globe.

The manufacture of salt is not only one of the oldest British industries, but one of great importance to the community. It is calculated that every grown man requires 7½ kilos. of salt per year to keep himself in health, and it is clearly of the first consequence that the salt used should be pure.

Murgatroyd's exhibit the special grades of salt used for human consumption, *e.g.*, for the curing of fish, for butter making, cheese making, dairy purposes, baking and confectionery purposes, as well as for table salt.

To the preparation of a free running table salt great attention has been paid by Murgatroyd's. Their "Merrisella" salt and "Danna" salt are the last word in this branch of the salt industry. Common salt, as is well known, is very hydroscopic. "Merrisella" and "Danna" salt can both be exposed to a damp atmosphere for long

periods without absorbing appreciable quantities of moisture. This *property is not* conferred by the addition of any substantial quantities of *other chemicals. It depends* essentially on physical treatcent of the salt by *means of new and interesting processes.*

In the chemical industry the chief use of *salt is for the manufacture of salt cake. For* this purpose a coarse but uniform salt, *which does not ball together,* is required. For other purposes in the chemical industry *a* quality free from the small quantities of calcium and magnesium salt contained in ordinary chemical salt is manufactured by Murgatroyd's.

There is a small but quite essential need for salt for pharmaceutical purposes. Murgatroyd's show their M. quality, which is guaranteed to conform to the requirements *of the British Pharmacopœpia.*

Lastly, sodium chloride is also used as a laboratory reagent, for which purpose Murgatroyd's manufacture and are exhibiting their A. quality, guaranteed analytically pure.

It will be seen, therefore, that the ancient salt industry not only provides a most important raw material for the chemical industry, but also impinges upon the territory of fine chemicals, besides supplying an article indispensable for the sustenance of the human race.

In addition to the above comprehensive exhibit of common salt (sodium chloride), *Murgatroyd's are also showing their two* well-known proprietary articles, "Lesrub" *Cleanser and* "Mursol" *Gravy Salt.*

PRICE'S PATENT CANDLE COMPANY, LTD.

Candles of all kinds, suitable for all climes, candles artistic, utilitarian, for the miner, for the piano, drawing room, hand-painted candles, and the prosaic dips. This exhibit *is an illustration of the ingenuity* and adaptability of the most famous candle house in the world. *It will be noted that* space is devoted in the exhibit to the new Trylite triangular candle. Trylite represents the very latest stage in the evolution of this illuminant. The Trylite candle fits any candle-holder without the necessity for shaving, wrapping, or wedging, and it yields a clear, rich light, is smokeless, and burns to the last fragment. In appearance it is highly artistic. The fluted sides of the Trylite candle not only lend charm to its appearance, but aid combustion and eliminate unsightly guttering. These candles are put up in attractive hexagonal packets of six candles, a useful shape for storing.

BRYANT & MAY, LIMITED.

It is doubtful whether any application of chemical science has been so beneficial and so convenient to civilised man as the discoveries which led to the production of the modern match. The cheapness and convenience of the every-day match have caused us to forget the great importance attached by our forefathers as recently as one century ago to the acquisition and maintenance of fire.

Messrs. Bryant & May's stand, representative of a comfortable English home, *will afford an opportunity of contrasting* the most efficient modern match with the laborious methods used by our ancestors to "strike a light." Side by side with specimens of the present productions of this famous house may be seen rare specimens of "fire-making appliances" brought to Wembley from the remarkable Bryant & May collection, which is now formed into a museum at Fairfield Works, Bow, and which is by far the most complete collection in the world containing many specimens which cannot be seen elsewhere.

Facsimile reproductions of the *Liliputian* matches supplied for the Queen's Dolls' House will also be on view, together with a model of the well-known Fairfield Works at Bow, which are second to none in the efficiency of their provision for the comfort and welfare of the people engaged in this vital industry.

This company has a daily circulation—seven days per week—of 150,000,000 matches—or three million boxes actually consumed in the United Kingdom. Associated factories in the Overseas Dominions add no less than one million boxes per day to this remarkable figure.

(To be continued.)

EXHIBITS IN THE SCIENTIFIC SECTION AT THE BRITISH EMPIRE EXHIBITION.

MR. T. V. BARKER.

Crystallography and Crystal Structure.

Among the exhibits recently added to the Scientific Section of the Chemical Hall at Wembley is a remarkably fine collection of

crystals, arranged by the Oxford Mineral Department. The exhibit mainly consists of laboratory products, and has been made possible by the co-operation of many members of the A.B.C.M. In fact, the specimens placed at Mr. Barker's disposal (who organised the exhibit) were so numerous that space could not be found for all.

The exhibit is divided into two parts: an introductory portion illustrating the more striking properties of crystals, and a gallery of "famous crystals," *i.e.*, those which have profoundly influenced the development of chemical and physical science. Amongst the latter are quartz and sodium ammonium tartrate, which led to the discovery of the connection between optical activity and enantiomorphism, and thence to the special formulæ of organic compounds; and crystals of copper sulphate, rock-salt and potassium ferrocyanide, which played an equally important role in modern X-ray explorations of crystal and atomic structures. Perhaps the most impressive crystal of all is the specimen of potassium ferrocyanide, actually used by Moseley in determining the characteristic X-ray wave-lengths of some 70 elements—a historic research which, perhaps more than any other, is accelerating the inevitable fusion of physics and chemistry.

A small section on the identification of crystalline substances by means of angular measurements is of great practical interest to the chemist. The many possibilities hereby opened up are epitomised by the inclusion of the largest crystal of "Salol" ever observed, which grew in the most unlikely of all places—a human intestine. Its formation was, of course, only rendered possible by the special circumstance that the melting point of phenyl-salicylate is only 2° or 3° higher than the body temperature.

The exhibit is fully documented, and affords a vivid picture of the history of crystallography—its origin in the province of minerals; its gradual emancipation in the nineteenth century as a separate science; and its recent recognition as the ground on which chemistry and physics most obviously meet. The concurrent improvement in technique is admirably brought out by the contrast between the old "contact" and Wollaston goniometers and modern instruments of great precision and utility.

MR. P. PHILIPS BEDSON.

Apparatus to Demonstrate the Explosive Inflammability of Mixtures of Coal-Dust and Air.

Air compressed to a pressure of 8 in. of mercury is conveyed to a jet, into a tubular of the glass-globe, in which, suspended from a second tubular, is a coil of platinum wire, which can be heated electrically. A third tubular is adapted to a glass tube on the open end of which fits a basin, attached to a rod forming part of a ballistic pendulum. The coal-dust from 0.5-1 gramme in weight is formed into a heap surrounding the jet. The sudden release of a "puff" of air serves to produce a cloud of dust, which, projected over the heated platinum wire, is unflamed, with an explosive impulse, registered by the movement of the pendulum.

With this apparatus, P. Philips Bedson and H. Widdas have shown (*Trans. Inst. Min. E.*, 1906, 1907 and 1910) dusts from different coals exhibit variation in the sensitiveness to inflammation, ranging from a dull charry red matter to almost a white heat. The influence of the factors (a) composition of the coal, (b) physical condition of the dust (fineness of sub-division), (c) proportion of moisture, (d) admixture of inert (incombustible) material, have been studied.

(*To be continued.*)

FLUXES AND SLAGS IN METAL MELTING AND WORKING.

(*Continued from Page* 331.)

A General Discussion on the above subject was held on April 28, by the Faraday Society and the Institute of Metals, with the co-operation of the British Non-Ferrous Metals Research Association and the Institute of British Foundrymen.

The following papers were communicated:—

Slags Produced in Melting Silver Alloys, by JOHN PHELPS.

In the years 1920, 1921, and 1922, the Mint has had occasion to melt and cast into flat bars for rolling large quantities of an alloy of the composition, silver 50 per cent., copper 40 to 41 per cent., nickel 10 to 9 per cent. This alloy is only perfectly melted above 1180° C., and consequently had to be

poured at about 1250° C., while the alloys of silver and copper previously used were best poured at about 1050° C.

In order to obtain sound castings and malleable metal it was necessary to add a deoxidiser to the melt; the protection afforded by a cover of charcoal fragments being insufficient. Metallic manganese and 8 per cent. phosphor copper were found most effective, and the resulting oxides formed slags with the silicates from the crucibles, stirrers, and covers, which gave some trouble in pouring.

In cases where a considerable amount of fluid slag remains in the pot, some of it finds its way past the float and causes inclusions in the castings; these soon break to the surface in rolling, and the defective portions of the strips have to be cut out and remelted: some waste of work is thus caused, but it is not so serious as that caused by small inclusions of slag which has never risen to the surface and may not be detected until a later stage of working: inclusion of the latter kind were found chiefly during a trial of cupro silicon as deoxidiser when very little slag appeared on the surface of the metal.

The alloys of silver and copper only did not require a deoxidiser, and the small quantity of copper oxide produced at the lower melting temperature adhered to the crucibles or stirrers and caused no trouble: there was no evidence of a fluid slag in these cases. When 0.05 per cent. each of metallic manganese and phosphor copper (8 per cent. phosphorus) were used with the above silver copper nickel alloy a very viscous slag was formed which could be kept out of the moulds without much difficulty, but which adhered to the crucibles and stirrers, to a troublesome extent in the case of the latter. The metallics left after crushing and sieving a sample of this slag contained silver to the amount of 4.8 per cent. of the slag, which therefore must have retained nearly 10 per cent. of metal. It also contained some carbon from the stirrer, which consisted of a graphite and clay composition.

The most fusible slag obtained included enough silver to make treatment for the recovery of the metal necessary, which can be readily done by fusing the slag with sand or borax.

The silver could be recovered from the more viscous slags by the same treatment, and owing to their smaller bulk no more of the fluxes were required.

In melting metal of less value it might be preferable to produce a fluid slag, provided that the latter could be rejected without recovery of the contained metal.

Subsequent experience with an alloy of the composition copper 70, silver 25, manganese 5 per cent., shows that similar slags are produced, though naturally in larger quantity.

Fluxes and Slags in Oxy-Acetylene Welding, by C. Coulson-Smith, M.Sc.

In the oxy-acetylene flame, two molecules of acetylene require, for complete combustion, five molecules of oxygen, and this reaction takes place in two stages. A molecule of acetylene unites with one of oxygen, forming one molecule of hydrogen and two of carbon monoxide. This carbon monoxide, on combustion, yields carbon dioxide, and the hydrogen yields water vapour.

Oxidation of the iron can be brought about by excess oxygen in the flame itself, atmospheric oxygen, and water vapour obtained from the combustion of acetylene.

With a perfectly regulated blowpipe, the oxide formation in mild steel welding is very slight, and in consequence fluxes are not generally used. The point as to whether molten iron actually is or is not capable of dissolving up to one per cent. of the oxide is a matter of variance of opinion.

In cast iron, the oxidation of the iron itself, and of the other constituents, renders welding difficult, and a process of puddling the molten metal is generally resorted to. The point of interest is that oxidation occurs, a slag having a higher melting-point than that of the metal itself is formed, and being more dense, sinks through the molten metal, and may be incorporated in the weld if not removed by some chemical means, such as the flux provides. The actual influence which the oxide exerts is to increase the surface tension. The surface tension of the metal is low, and the object of using the flux is to overcome the excess set up by the oxide formation, so as to bring the oxide to the surface. The constituents of the flux either dissolve this substance, or float it off along the line of weld. The most general constituents of the fluxes for cast iron are mixtures of sodium borate, sodium carbonate, sodium bicarbonate and silica; as reducing agents one sometimes finds incorporated a trace of aluminium.

Probably the silica reacts with the sodium carbonate, forming sodium silicate. This reacts with the sodium borate, forming a borosilicate and free borax which, being a solvent for oxide iron, forms ferrous silicate. When this molten ferrous silicate is exposed to the air, partial oxidation takes place and crystals of Fe_3O_4 are formed, and such a slag in contact with the impure metal gives up its excess of oxygen (from the Fe_3O_4) to the oxidisable elements present, and again becomes reduced to ferrous oxide. In the welding of cast iron, ferro-silicon rods are used as filling material, which contain approximately 3 to 3.5 per cent. silicon, and this replaces or can replace any loss of silicon. Titanium, as an ingredient, is also made use of, especially on account of its combining property with nitrogen.

The fluxes used for copper are generally either sodium borate or a mixture of sodium borate (anhydrous) and boric acid, sometimes with the addition of sodium chloride to lower the melting-point of the flux. The following reactions seem to take place. The sodium borate and the boric acid at high temperature yield boric anhydride, a vitreous mass, soluble in water, forming boric acid. This boric anhydride combines with the oxide of copper, forming copper borate. The melting-point of this borate is fairly high, and the addition of the sodium chloride has been found to bring the melting-point lower than that of the copper itself.

Fluxes for brass, bronze and aluminium were also considered.

Non-Metallic Inclusions in Metals, with Special Reference to Aluminium, by A. G. Lobley.

Almost invariably metals are affected detrimentally by inclusions of non-metals; the mechanical properties may be influenced, the susceptibility to corrosion increased, or the appearance of the polished surface detracted from.

The importance of inclusions differs very greatly, not only because the effect itself varies with the nature of the metal and the importance with the application, but also on account of the very great variation in the facility with which the inclusions may be prevented or removed.

The subject, so far as steel is concerned, has been very clearly handled by McCance, who, after referring to the very high percentage of failures due to this cause alone, by applying Stokes' law, showed the probable velocity with which such particles would rise to the surface, and concluded from the figures thus obtained that it was improbable that particles smaller than 0.01 mm. in diameter would succeed in reaching the surface of the metal.

With aluminium the conditions are different from those prevailing with most other metals.

The oxide, when present in appreciable amount, reduces the ductility as well as having some effect on other mechanical properties. What the effect is of the small quantity of oxide in the best commercial metal is unknown, since there is no data regarding the properties of aluminium completely free from any kind of inclusion, if indeed such metal has been prepared.

If the effect of small amounts of non-metallic substances is very appreciable, then the subject is also of interest in its influence on data regarding aluminium alloys, the oxide content of which may be a very variable quantity.

Fluxes and Slags in Welding, by W. Spraragen, Secretary, American Bureau of Welding.

This contribution is a digest of the opinions of American experts on the subject. No flux is used, to the author's knowledge, in thermit welding.

Fluxes play an essential part in steel manufacture in modifying the chemical and physical properties of the product. In fusion welding particularly, electric arc and gas welding, where the metal must be raised to a sufficient temperature to melt it, attention was given to the possibilities of the use of some kind of fluxes and slags in modifying the physical and chemical qualities of the resultant weld.

In welding by the electric arc, the metal is raised to a very high temperature in an extremely small space of time. A different type of flux might therefore be necessary to react properly in this short space of time, and at this high temperature, than would be required with a flux in steel manufacture, where the temperature was much lower and the time for reaction much longer.

The knowledge of the use of fluxes in welding is in a very unsatisfactory state. Practices are based largely on the results of practical experience, where the use of flux

has been found to give results which have proven satisfactory in service. Very little scientific effort has been made to analyse *the functions of the flux, their best composition*, their best methods of application and the results attained from their use. It is believed by some that the use of flux will in some instances give better results than welding without its use. Test results are needed to substantiate these opinions.

Sulphurising and Desulphurising of Metals by Basic Slags and Fluxes, by B. Bogitch (Translated).

The *first of these operations takes place* principally in the fusion of minerals to mattes. The second in the course of purifying metals, notably during the treatment of steels in electric furnaces. In both cases, *the slag or flux only intervenes in the re*actions in proportion to its content of lime, free or in combination with sulphur. We can therefore express the reaction in the following form:

$$MS + CaO + C = M + CaS + CO.$$

From this formula it can be deduced that for the desulphurising of a metal to succeed, not only is a basic flux necessary, but also an excess of carbon. For if the latter be not in excess, the calcium sulphide decomposes, and the liberated sulphur combines with the metal. An equilibrium, therefore, always exists in the distribution of the sulphur as between the metal and the flux.

The *coefficient of distribution of the sul*phur for any metal is not known for certain. Even in a case as important as that of the desulphurising of steels, the distribution of the sulphur between the limestone flux and the molten metal is not known. Experimentally, 100 grams of metal, with the addition of a corresponding quantity of sulphur, are melted in a graphite crucible at a temperature of 1500-1600° C. in a small electric granular resistance furance.

When completely melted, 20 grams of desulphuriser (lime, limestone flux, lime and fluor-spar) are introduced into the crucible, and agitated by means of a carbon rod. At the end of a given time, the metal is poured out, and the slag collected.

The results do not enable us to calculate exactly the coefficients of distribution of sulphur for the different metals which we have studied but they give some indication of their order of magnitude. Thus, in the case of iron, the sulphur absorption of the flux can be more than 500 times as great as that of the metal. For nickel or copper this coefficient of absorption is still greater. With manganese, however, it is smaller than with iron.

Thanks to these coefficients being as high as they are, it is possible to prepare pure metals by separation directly from their sulphides.

Certain metals, heated in a closed chamber *with carbon, have their sulphur con*tent reduced. This desulphurising is slow, and affects only quite superficial layers of *the metal.*

Metals obtained industrially as agglomerates are extremely porous bodies, consequently presenting considerable surface of action, though of small volume. In this *case, desulphurising is much more rapid.* It is produced both in the interior as well as the exterior of the agglomerate. In this way, very considerable changes can be effected in both the chemical composition and consequently in the mechanical properties of the metals.

Oxidising Fluxes in the Melting of Non-Ferrous Metals, by A. Portevin (Translated).

In the great majority of cases, the role of fluxes employed in melting and soldering of non-ferrous metals and alloys may be classified:—

1. *As a protection*, to prevent oxidation. This is the role of melted chlorides for alkali metals, and metals of the alkaline earths, aluminium and magnesium.

2. *As a reducing agent*, *i.e.*, to bring back to the metallic state the oxide of the melted metal; *e.g.*, certain fluxes containing manganese or carbon used in the copper foundry.

3. *As a melting agent.* Acting by dissolving the inclusions and oxides of the molten metal, or the oxides resulting from the reducing action of the deoxidisers, *e.g.*, borax in melting copper, or cryolite for aluminium.

4. *As an agitator*, by evolution of gases and vapours, stirring up the metals, and helping the inclusions to rise, *e.g.*, the action of volatile ammonium chloride in the aluminium foundry.

For certain fluxes, the action is complex and multiple. Thus, the alkaline fluorides

used in the melting and soldering of aluminium and the metals of the alkaline earths are partially decomposed by some among them with formation of sodium, which is incorporated in small amounts, whilst, on the other hand, it is relatively volatile. There is, at the same time, a modification of the surface tension and of the fluidity, a stirring of the bath and dissolution of the inclusions.

The great majority of bronze castings from a metal melted in a heavy oil furnace with direct heating of the metal by the flame of a blow pipe, were riddled with a number of small blow-holes; these blow-holes occurred whatever method of pouring, the shape of the castings, their position in the mould, and their feeding, was used, or whatever the care taken in the preparation and drying of the moulds and cores.

After careful examination of the blow-holes with a lens, it was observable that the cavities were round in shape without inclusions of foreign matter, and appeared clean and unoxidised. We naturally thought that they were the result of bubbles of reducing gas previously dissolved in the liquid metal, and liberated in the mass during cooling following casting. This abnormal absorption of reducing gas by the molten metallic bath is due, apparently, to the method of heating, creating in the furnace a very reducing atmosphere.

To prevent this state of affairs, we had the idea of supplying previous to melting, an oxidising body in the nature of a metallic oxide. As the bronze used had to contain a small quantity of lead (the composition being Cu = 88, Sn = 6, Zn = 3, Pb = 3), we introduced oxide of lead in the form of litharge (PbO), or better still, red lead (Pb_3O_4), in a sufficient quantity to allow the right amount of lead in the final mix.

The metallic bath of about 300 kgs. was melted and maintained at the convenient temperature; the surface was skimmed and sprinkled with about 0.05 per cent. red lead, the melt was stirred and the casting proceeded with, with the usual precaution.

The result obtained completely verified our conjecture. The trouble described disappeared completely, and a practice of several years confirmed the accuracy of our interpretation.

This unexpected action of oxidising agents as an addition and flux for foundry use, appeared to us worthy of bringing up at the general discussion organised on the subject of fluxes and slags.

The annual autumn meeting of the Institute of Metals will take place in London on September 8-11.

A conference on "Science and Labour" is to be held at the British Empire Exhibition on May 30 and 31. It has been arranged by the British Science Guild with the National Council of the Trades Union Congress and the Labour Party, and will be opened by the Prime Minister. There will be a number of discussions on Science in Government; Scientific Research in relation to Industry; Co-operation of Science and Labour in Production; Science and the Human Factor; and Science in Education.

At the annual general meeting of the British Chamber of Commerce of Turkey and the Balkans it was pointed out that opportunities existed for furthering chemical and other markets in the Near aEst.

Messrs. B. G. Teubner are publishing a "Chemischer Wörterbuch," compiled by Prof. Remy, of Hamburg.

PROCEEDINGS AND NOTICES OF SOCIETIES.

THE ROYAL SOCIETY.

May 22.

Paper read:—

Prof. J. W. Gregory, F.R.S., and C. J. Gregory. *The Geology and Physical Geography of Chinese Tibet, and its Relations to the Mountain System of South Eastern Asia.*

Papers read in title only:—

Madge Kaye and Dorothy Jordan Lloyd. *A Histological and Chemical Investigation of the Swelling of a Fibrous Tissue.* Communicated by Dr. R. H. Pickard, F.R.S.

The behaviour of a heterogeneous system, such as skin in water, acids and alkalies, differs in several important respects from that of a homogeneous system, such as gelatin. The fibres of skins are grouped

into regular bundles and are divided longitudinally into fine threadlike fibrils. These are embedded in a colourless semi-fluid matrix, the "inter-fibrillary substance," which has been found to have the characteristics of an albumen. The coagulation of this during drying has a very important effect on the swelling of dried skins in water, acids or alkalies.

The fibres and fibrils of fresh skin are in a state of internal strain, due to (*a*) the inherent structure of the fibril, and (*b*) their arrangement in the tissue. These strains are released when the fibres are swollen, but new temporary strains are produced by encircling threadlike elements binding the fibres together, which only become visible when the bundles are in a swollen condition. Drying introduces additional strains, but destroys the constricting bands; thus, no temporary strains are produced during swelling.

In swollen skins, water is present in at least two conditions—(*a*) imbibed between the fibres or fibrils, (*b*) combined with the internal substance of the fibrils. In fresh skins the inter-fibrillary albumen does not prevent absorption of water in either way, but the coagulated albumen of skin dried under the influence of heat or ultra-violet light offers considerable resistance to both. Skins dried under conditions which do not coagulate albumen are brought nearer to fresh skins; solutions which disperse coagulated albumen increase the power of water-absorption of dried skins, but some irreversible changes seem to occur in drying. Irreversible changes also occur during swelling of both fresh and dried skins.

C. H. BROWNING, PROF. J. B. COHEN, F.R.S., S. ELLINGWORTH and R. GULBRANSEN. *The Antiseptic Action of Compounds of the Apocyanine, Carbocyanine and Isocyanine Series.*

A series of compounds belonging to the apocyanine, carbocyanine and isocyanine groups have been prepared and examined for their antiseptic action. In general, these substances are very powerully antiseptic towards *Staphylococcus aureus*, but are much less active towards *B. coli*. In the presence of serum their antiseptic action is practically as well marked as in watery medium. Unlike the acridine series, the introduction of amino-groups did not enhance the action of the cyanine compounds. In the isocyanine series the introduction of side-chains into the quinoline fraction of the molecule, as compared with their presence in the quinaldine fraction, had a depressing effect on antiseptic potency. Otherwise significant alterations in antiseptic power were not observed as a result of variations in chemical structure within the groups.

H. J. WATT. *Dimensions of the Labyrinth Correlated.* Communicated by Prof. D. Noel Paton, F.R.S.

These correlations are based upon the measurements of the labyrinth published by Dr. A. A. Gray in his two volumes, "The Labyrinth of Animals," London. 1907-8. They are the complement of the correlations already made by Dr. Watt on part of these data and published in the *Proceedings*, B, 1916 (vol. 89, pp. 410-431) ("The Typical Form of the Cochlea and its Variations").

The general conclusion to be drawn from these other correlations is that the dimensions of the semi-circular canals of mammals (and birds), like those of the cochlea, are highly correlated with one another and with the length of the head and body, so that they may be said to maintain a typical form varying in scale with the length of the head and body. They show no noteworthy signs of variation from type, except that the dimensions of the canals in the porpoise and the Cape sea-lion are relatively unusually low, while the dimensions of the body and head of the whale, the sea-cow and the horse are relatively unusually high.

JUNIOR INSTITUTION OF ENGINEERS.

MAY 9.

Paper read:—

Methods of Purifying Water and Sewage, by F. W. FOLLETT.

An important rule to observe when considering the bacterial efficiency of sand filters is the maintenance of a fixed head of water, and of an unbroken film of fine matter on the sand surface. If this rule is not observed, the efficiency will immediately be affected, and it is usual for water supply authorities to maintain a bacterial laboratory, the staff of which keep a regular watch on the results from each filter. The vast

area covered by slow sand filters made their use impracticable in most industrial undertakings, although their use was almost universal in water supply companies.

Dealing with sewage purification, the broad irrigation, intermittent filtration, mechanical purification, and artificial biological purification methods, as well as sterilisation by ozone and chlorine were described. The activated sludge process was the complete oxidation of the sewage in tanks. Diffused air was passed through the liquid sewage until the solid matter that was held in suspension had reached a high state of bacterial activity. The sewage was then allowed to settle and the clear effluent drawn off. A certain amount of sludge was always kept in the tanks, and the sewage passed through slowly and kept intimately mixed with the sludge by blowing. In this way the sewage was thoroughly aerated and oxidised. This process was effected without the use of bacterial filters.

SOCIETY OF GLASS TECHNOLOGY.

A joint meeting with the British Society of Master Glass Painters was held in University College, London, on May 27. The following papers were read and discussed:

The Decay of Window Glass from the Point of View of Lichenous Growths, by MISS ETHEL MELLOR, D.Sc.

The Decay of Mediæval Stained Glass, by MR. NOEL HEATON, B.Sc.

The Weathering and Decay of Glass, by PROF. W. E. S. TURNER, D.Sc.

SHEFFIELD UNIVERSITY, MAY 29.

The following papers were read and discussed:

Alumino-Silica Minerals in Fired Glass Pots, by W. J. REES, B.Sc.TECH., F.I.C.

The Effect of Various Constituents on the Viscosity of Glass, by S. ENGLISH, M.Sc.

The Thermal Endurance of Glass, by V. H. STOTT, M.Sc.

ROYAL MICROSCOPICAL SOCIETY.

The section of the Society which has been formed to deal with the Industrial Applications of the Microscope, and to assist in the development of industrial research in British Industries, met on May [illegible]. Mr. A. Chaston Chapman, F.R.S., F.I.C., P.R.M.S., presided.

Messrs. R. & J. Beck, Ltd., exhibited a new analysing prism for use over the object glass, which does not possess any astigmatism.

Messrs. Ogilvy & Company exhibited a Leitz binocular tube attachment for monocular stands, and a new Leitz dissecting microscope.

MR. E. SHELDON LEICESTER read a paper on *The Use of the Microscope in the Examination of Paper.*

MR. KENNETH MACLENNAN, M.C., B.Sc., also read a paper, entitled *The Microscopy of Soaps.*

THE INSTITUTE OF METALS.

The fourteenth annual May Lecture will be delivered on June 4 by DR. F. W. ASTON, F.R.S., whose subject is *Atoms and Isotopes.*

THE PHOTOMICROGRAPHIC SOCIETY.

The annual meeting and exhibition was held at King's College, Strand, on May 15.

In addition to the usual business, two alterations were made in the rules, and the President announced that the Barnard Medal had been awarded to an American member, the Martin-Duncan Certificate to Mr. A. W. Dennis, and the Lambert Award for improved technique to Mr. W. R. Biers.

Amongst the especially interesting exhibits were Messrs. C. Baker's new improved R.M.S. microscope, with a new pattern substage and coarse adjustment slide and "Corneal magnifier," and Messrs. Kelvin, Bottomley and Baird's mercury vapour lamp for ultra-violet light microscopy. The Wratten division of Kodak, Ltd., showed a range of colour filters for use in photographic and visual microscopy. Examples of work with the aid of the filters included a series of coloured transparencies of time spectra of various elements. Messrs. W. Watson & Sons showed various patterns of their standardised microscopes.

Other exhibits were a focussing stage by Mr. Newton; stereo-transparencies by Mr. E. Cugner; sections of diatoms in calcareous mudstone by Mr. C. H. Affyn; transparencies of high-power ultra-violet light photomicrographs of living organisms taken by the late Prof. H. Kruis, of Prague, communicated by Mr. E. H. Ellis; cultures and photographs of various fungi associated with "dry rot" by Capt. Branfoot.

Mr. E. A. Robins was elected President for the forthcoming session.

NOTICES OF BOOKS.

The Life of Sir William Crookes, O.M., F.R.S., by E. E. FOURNIER D'ALBE, D.Sc., F.INST.P., with a Foreword by SIR OLIVER LODGE. London: T. Fisher Unwin, Ltd. 1923. For price see copy at *The Chemical News* Office.

The life of Sir William Crookes has now been in the hands of the public for some months, and the work has been reviewed in most journals, in particular those devoted to the various branches of science with which Sir William Crookes was most occupied.

As representing *The Chemical News*, in which the accounts of so many of his researches have appeared, it seemed fitting to us to refrain from making hasty reference to the "life," and to wait until the work had been fully considered in the Press, and then to give a few words of acknowledgment of the many kindly references already made to the publication, and to add a little in the way of criticism and supplement.

To the writer, who was in very close association with Sir William for nearly 40 years, there is a certain amount of quiet satisfaction in so doing, for he records with gratitude the many kindnesses he received during that long period.

In his preface, Mr. Fournier D'Albe refers to the fact that Sir William had planned to publish his reminiscences, together with a collection of his scientific papers. It is much to be regretted that he was unable to do so, and there can be very little doubt as to the reason.

By the death of Lady Crookes, which occurred in 1916, Sir William lost not only his lifelong partner, but with her passed away his chief interest in life, and the contemplated labour that, with her encouragement, would have been a pleasureable pastime, lay untouched and uncared for.

Mr. Fournier D'Albe refers to his work of sifting the 40,000 documents that were put into his hands as an arduous one, and we can sympathise with him, and if we suggest that much of the "Life of Sir William Crookes" reads like a collection of documents and contains some few inaccuracies, we also fully realise that the task undertaken by the author was one of extreme difficulty.

The book opens with a foreword by Sir Oliver Lodge, who writes from personal knowledge, and his description of the "well ordered, though small, laboratory—from which phenomena of stimulating novelty might at any time emerge" is very apt. Had the collected writings of Sir William been published, people would have been astonished at the diversity of subjects that occupied the forty years' continuous work in that small laboratory; the note books during that period fill twenty-two volumes of some 500 pages each.

The writer, who, in 1882 succeeded C. H. Gimmingham as Assistant, was first engaged in the production of the incandescent lamp described on page 305, and it is interesting to note that this form of lamp was used to light the house, and its manufacture, together with the sockets, switches and other details was carried out in the laboratory, Sir William himself working at the installation. The cables were threaded through glass tubes and laid under the floors, and the necessary current was generated by an Otto gas engine installed in the basement.

The name of Sir William Crookes was known to the world by reason of the discoveries that he made and the numerous researches that he published, and it is to be regretted that immediately after his death an immense volume of correspondence and notes was destroyed by his executors. Reference has been made to the methodical habits of Sir William. It was his rule never to destroy a paper—every note connected with his activities from the commencement was indexed and stored in boxes with the greatest care.

Had Mr. Fournier D'Albe been able to make a selection from this material before its consignment to the paper mills, many unfortunate mistakes would have been avoided, and the life would have contained much more valuable matter than it does, and many details that we are quite sure Sir William would preferred to have remained as private family matters would never have gone into print.

We, however, cannot blame the author for this, for he was only able to use the material placed in his hands.

Undoubtedly, much information was expected by those interested in psychological researches, and it will be noticed that beyond the oft published accounts of his early dealings with Home, Florence Cook, and others at the commencement of his public career, nothing of importance will be found in the book. This will be disappointing, but it is in no way connected with the destruction of documents referred to. It is a fact that no such investigations were at-

tempted after 1881, except a few attempts at so-called Spirit Photography, and these gave results that were capable of very *simple explanation*.

The writer, who was continually occupied in that "little laboratory" for so many years, recalls the immense volume of work that was done in connection with Radiant Matter Spectroscopy, involving, as it did, exact chemistry, electricity, and general physics, together with a deal of mechanical work, for it was the practice that all the original apparatus needed for research should be made at the laboratory.

A spectrograph of original design was constructed to photograph the very faint spectra given by the rare earth compounds under cathode discharge *in vacuo*, and this was followed by a very much larger one, together with micrometer measuring apparatus, for the photography and determination of the wave-lengths of the spectrum lines of the elements. These instruments, which embody many novel features in construction, were acquired by the Council of the Institution of Electrical Engineers, and have now been removed to South Kensington, where they form part of the collection of original apparatus there accumulating.

It was the intention of Sir William to publish a complete Atlas of the Photographed Spectra of all the known elements, and this almost completed work was left unfinished.

But the writer must not allow himself to wander into reminiscences. Sir William Crookes' his laboratory, his books, and his tools have passed away, leaving only a happy recollection, but those who knew him well will be grateful to the biographer for collecting and recording what he has of the life of one of the most prominent workers in the borderland of knowledge during the last half-century.

J. H. G.

Colloid Chemistry, by The. Svedberg. Pp. 265. New York: The Chemical Catalog Co., Inc., 19, East 24th Street. 1924. $3.00.

This monograph, in the series issued by the American Chemical Society, deals with the formation of the Colloid Particle, the particle as a molecular kinetic unit, and as a micell. The volume is divided into four parts which cover a study of the colloidal state under the headings indicated.

The first section, except for some important and interesting new studies in connection with the photographic grain, follows the lines of the author's "The Formation of Colloids," 1921. In a monograph of this kind the author has naturally included much matter emanating from his own laboratory. This has, in the reviewer's opinion, added, rather than detracted from the value of the book.

Part two includes a complete account of the Brownian movement. The size, shape and structure of the colloid particle are also studied in detail.

Part three deals (but more briefly) with adsorption phenomena, endosmosis, *cataphoresis, coagulation, gel-formation, etc.*

A pamphlet of 48 pages, entitled *Boric Oxide as a Constituent of Glass*, compiled by H. Goulding-Brown, has been issued gratis by Borax Consolidated, Ltd., 16, Eastcheap, E.C.

In a foreword, Prof. Turner mentions that one of the most important improvements obtained by adding borax to the constituents of glass is to enhance the durability of the product.

The information has been arranged in a scientific and attractive manner. At the end is a bibliography of recent papers bearing on the subject.

New Patents.

This list is specially compiled for *The Chemical News* by Messrs. Rayner & Co., Registered Patent Agents, of 5, Chancery Lane, London, from whom all information relating to Patents, Trade Marks, and Designs can be obtained gratuitously.

Specifications Published this Week.

214293—Tizard, H. T., Chapman, D. L., and Taylor, R.—Halogenation of hydrocarbons and their derivatives.

214330—Clayton Aniline Co., Ltd., and Grundy, J. G.—Treatment of acetyl cellulose in alkaline liquids.

201131—Bhopal Produce Trust, Ltd.—Recovery of calcium oxalate and other materials from trees.

194694—Poma, G.—Process for the manufacture of *p*-aminophenol.

Abstract Published this Week.

212768—Sulphuric acid.—Sulfur Akt-Ges., of 2, Thorgasse, Zurich, Switzerland, and Franck, W., of 1, Wohlgelegen, Mannheim, Germany.

In the chamber process for making sulphuric acid, the *Glover* and *Gay-Lussac* towers are used without any filling, and the acid is sprayed into the top of them in a fine spray, for instance by spraying-nozzles. The towers consist of a lead casing with stone lining.

Messrs. Rayner & Co. will obtain printed copies of the published specification and abstract only, and forward on post free for the price of 1s. 6d. each.

THE CHEMICAL NEWS,
VOL. CXXVIII. No. 3347.

A NOTE ON "THE SIGNIFICANCE OF THE ELECTRODE POTENTIAL"

(BEING A REPLY TO THE CRITICISM OF J. A. V. BUTLER).[1]

By J. HEYROVSKY, D.Sc., Ph.D.,
CHARLES' UNIVERSITY OF PRAGUE.

A recent paper[2] of the present author bearing the above title has been criticised by J. A. V. Butler,[3] who regards certain stages of the author's cyclic process as irreversible, and deduces that if strict reversibility be observed, the sum of the electric potentials, which the present author regards as the electrode potential, must be zero.

That neither of these objections is justified becomes obvious from the following remarks:—

Firstly, all the "energy" or "work" terms in the writer's cycle mean, of course, free energies (maximum work), which are imagined to be gained, if the process is *carried out in a reversible manner.* There is no doubt that any of the processes involved lead to certain states of equilibrium, from the constants of which, as Mr. Butler indicates, the free energies can be calculated. However, the present author's shorter way of expressing these free energies simply by symbols I, K. M, H, is more general, being independent of special assumptions such as Butler's, that the law of mass action holds between gaseous ions and electrons. Thus, for instance, the present author's K_{HOH}, expressing the maximum work done in decomposing water-vapour into ions $H^{\cdot}$ and OH', all at unit pressures, stands for Butler's $\frac{RT}{F} \log K_{H_2O}$,

and similarly in all other cases, the author's symbols denote "affinities" of the respective processes.

Mr. Butler thinks it quite wrong to regard the "ionisation potential," I, as a measure of the free energy. This physical constant, derived from electrometric measurements, is usually interpreted as corresponding to the convergent frequency, ν_∞, of the principal series of the line spectrum, and as such it should be related to the total energy of ionisation. However, the picture of ionisation-mechanism with the "inelastic electronic impacts" leads us to a different view: The kinetic energy, I.F., of the electrons, which ionise the atoms by collision, will *only then be equal to the* total energy of ionisation, $h\nu_\infty$, when a prevailing part of the atoms have their valency electrons in the innermost level. This happens at comparatively low temperatures. At high temperatures, however, many of the atoms will be "excited" (by molecular impacts and temperature *radiation), i.e., have their valency electrons* in outer levels. Then the kinetic energy necessary to ionise by impact such "excited" atoms will be less, and therefore, at that temperature, the "ionisation potential" will be less than the total energy of ionisation, $h\nu_\infty$. Finally, at extremely high temperatures, where practically all atoms must be in "excited" or ionised conditions, very little energy would be necessary to ionise them completely, *i.e.*, the "ionisation potential" necessary to be applied to ionise this very hot gas completely would be nearly zero, although the total energy change of ionisation still remains $h\nu_\infty$. It is evident that the electrometric "ionisation potentials" measure not the total but the free energy of the ionisation process. The experimental results agree with the total energy calculated from spectral lines, because at ordinary temperatures *nearly all* atoms are "unexcited," that is to say, in about the same state as at absolute zero. At this temperature, as is evident from the Gibbs-Helmholtz equation,

$A = Q + T.\frac{dA}{}$, where A denotes the affinity

[1] *My friend, Prof. Heyrovsky, has asked us to publish this reply to criticisms of his work, which have appeared elsewhere, and it is with pleasure and in the interest of science that we gladly accede to his request.—J.G.F.D.*

[2] *Roy. Soc. Proc., A.*, 1923, CII., 628.

[3] *Ibid.*, CIV., 667.

or the free energy of the process

$$Me^{+} + \epsilon \rightarrow Me,$$

and Q is the total energy or heat of reaction, A equals Q.

At ordinary temperatures, at which we are dealing with galvanic cells, the term $\frac{dA}{dT}$ must still be negligible, otherwise gases would be luminous or ionised. Hence even *from Butler's point of view, the "ionisation* potential" can be taken as equal to the free energy of ionisation. The symbol I, standing for free energies, is therefore right.

This will suffice to disprove Butler's first objection "that several stages involve irreversible processes and that free energy and total energy terms are used quite indiscriminately" (*l.c.*, p. 668). Whilst this first objection was chiefly due to mistaking the free energy symbols for "total energies," Mr. Butler's second objection, that the sum of the electric potentials round the cycle is zero, is based on a thermodynamic error.

In his correctly deduced equation (1), (only the sign before the last term of this equation should be + instead of -), Mr. Butler has already the necessary relation between the factors (potential, temperature and concentrations), which govern the electrode equilibrium. Now he thinks it possible to simplify it further by supposing the vapour pressure, p, of the dry metal, to be in equilibrium with the vapour, P, of the solution, and so for the rest of the pressures. But at the electrode, the metallic vapour is not in chemical equilibrium with the solution; it might be acted upon by water and yet have its characteristic potential, as in the case of all "base" metals, whose electrolytic potential is well defined, which, however, would totally burn away in water before coming to that equilibrium which Mr. Butler is now introducing as a further condition.

To make Butler's mistake clearer, let us substitute for the constants K_{Me}, K_{MeOH} and K_{H_2O} in his equation (1) the concentrations which exist above the dry metallic phase ($\overset{+}{Me}_m$, ϵ_m, p), and above the solution ($MeOH_s$, $\overset{+}{Me}_s$, OH'_s, $H^{\cdot}_s$, P).

We obtain:

$$\pi + E_s - \phi_m = \frac{RT}{F} \log \frac{\overset{+}{Me}_m}{\overset{+}{Me}_s} \quad . \quad . \quad . \quad (2).$$

To find zero, Mr. Butler must have regarded the two quite different concentrations as identical. This is inadmissible, since $\overset{+}{Me}_m$ means the pressure of metallic ions over the dry isolated metal, whereas $\overset{+}{Me}_s$ means the concentration of (unhydrated) metallic ions, imagined to exist in the vapour of the solution, which contains the hydroxide MeOH.

Different concentrations from different stages of a cyclic process must never be confused; by equating them, Mr. Butler brings in a new condition, from which he obtains the result that the total electrode potential is zero. Butler's case would be possible only in such a special concentration, where the water vapour does not react with the metal; this is, of course, for base metals unrealisable, and could be realised only with a special noble metallic electrode.

To disclose Mr. Butler's sophism further, let us examine the sum of the potentials $\pi + E_s - \phi_m$, which he believes to be zero. For this purpose, imagine two such electrodes, consisting of two different metals, each dipping into a solution of its own ions, and let the solutions be in contact; for simplification, disregard the diffusion potential, which might arise at this junction. Now transfer one unit positive electric charge from the first metallic electrode through the solutions into the second metallic electrode (electric work $= +\pi + E_s - E' - \pi'$). The same will be effected with the same electric work, if we pass one unit negative charge of electrons in the reversed way, that is, from the second metallic electrode to the first one. To do this we have to bring the electrons from the second metal across its surface ($-\phi'_m$) and through the air into the first metallic electrode. In doing this, we carry the charge through the potential of the air-condensor formed by the two metallic surfaces, having their electrode-potentials, E and E' respectively; the work is thus equal to the E.M.F. of this cell (taken with the reversed sign, owing to the negative charge), or it is E'—E. The condensation of electrons into the first metal ($+\phi_m$) completes this transfer.

Finally, to be in agreement with Mr. Butler's "electron-gas"* treatment, we must not omit the work term $-\log \epsilon'_m/\epsilon_m$,* which accompanies the transfer of electrons from the second surface, above which they exist at the pressure ϵ'_m, to the first one, where they exert a pressure ϵ_m.

Now we can equate:—

$$E' - E + \frac{RT}{F}\log\frac{\epsilon'_m}{\epsilon_m} = \phi'_m + \phi$$
$$= \pi - \pi' + E_s - E'_s.$$

Evidently

$$E = -\pi + \phi_m - E_s - \frac{RT}{F}\log\epsilon + \text{const.}$$

Now, since both the corrected Butler's as well as the author's cycles are reversible, they must give coinciding results for E.

Indeed, we obtain for Butler's equation

(1) on substituting $K_{H_2O} = \frac{H^{\cdot}_s.OH'}{P}$

$$-\pi - E_s + \phi_m = -\frac{RT}{F}\log p - \frac{RT}{F}\log K_{Me}$$

$$+\frac{RT}{F}\log K_{MeOH} - \frac{RT}{F}\log\frac{OH_s'}{MeOH_s} + RT\log\epsilon_n;$$

writing the second and third term in the author's manner as affinities, I and M, and introducing real concentrations, C_{OH} and C_{MeOH}, remembering further that these particles are hydrated, we obtain—substituting E:

$$E = K - \frac{RT}{F}\log p + I - M + \frac{RT}{F}\log$$
$$C_{MeOH}/C_{OH} - H_{MeOH},$$

where K is independent of the nature of the metal and H MeOH is the free energy of hydration of the hydroxide. This equation is identical with the chief equation deduced by the present author in his criticised communication (*l.c.*, p. 631, 8th line), which involves the basic constant, K_b, of the hydroxide in the ratio C_{MeOH}/C_{OH} (being equal to $C_{Me.}/K_b$), and from which his equation (1), p. 631, directly follows.

* *To treat electrons as a gas, the terms should be multiplied by a small fraction* $\varkappa$ (=0.04); *see H. A. Lorentz, "Solvay report,* 1911," *Abhandl. d. Bunsen Ges.*, No. 7 (1914), p. 32; *A. D. Fokker, Arch. Neerland. scien. ex. et nat., S. III. A. t. IV.*, p. 394 (1918).

SUMMARY.

1.—It is explained that—contrary to J. A. V. Butler's statements—no stages of the cyclic process devised by the author are irreversible, and that everywhere only free energy terms are used.

2.—Mr. Butler's proof, that the sum of the potentials round the cycle is zero, is shown to be faulty. When the wrong step in Butler's cycle is avoided, it leads to the same relation between the electrode potential and the basic and ionisation constants as has been deduced by the present author, thus furnishing a further proof of the correctness of the deductions made by the latter.

THE HYDROGEN OVERVOLTAGE OF METALS AND THEIR CHARACTERISTIC PROPERTIES.

PART I.—OVERVOLTAGE AND VALENCY.

By EDWARD J. WEEKS, M.Sc., A.I.C., F.C.S.

In this paper and the following ones, the author hopes to give a critical survey of the connection between the hydrogen overvoltage of the metals and their properties.

For this purpose we may define the hydrogen overvoltage of a metal as the difference in potential between an electrode of that metal at which hydrogen is being liberated by electrolysis and a hydrogen electrode.

The work of Pring, Newbery, and of Sand and Weeks has shown that this potential is best measured by allowing the working electrode to be connected alternately with great rapidity to the source of current and to a connection leading through a potentiometer to an auxiliary electrode.

For full particulars as to the measurement of overvoltage, see Sand, Weeks, and Worrell (*J.C.S.*, 1923, CXXIII., 456), where full references may be found.

In 1916, Newbery (*J.C.S.*, 1916, CIX., 1107) put forward the idea that the overvoltage of a metal was a function of its

valency or, in other words, it was a periodic function. He based a theory of the formation of unstable intermediate hydrides on this assumption. It is to this theory that we now turn our attention. For most of the metals Newbery was the first to determine the overvoltage. If, however, we take an average of all the values obtained by different workers, we find that we are totally unable to connect the hydrogen overvoltage of a metal to its valency. With regard to the actual values of overvoltage given in the table below, it should be pointed out that the overvoltage of a metal depends on the current density for low current densities. At current densities above 100 millicoulombs per sec. cm^2 most authors have found the overvoltage to be constant. All values for average overvoltages were taken above this value and at 20° C.

TABLE.

Metal.	Over-voltage assumed by Newbery.	Over-voltage observed by Newbery.	Average Obs. O.V.
Mercury	0.70	0.26	0.69
Cadmium	0.70	0.48	0.50
Zinc	0.70	0.75	0.60
Thalium	0.50	0.53	0.54
Lead	0.45	0.28	0.61
Bismuth	0.42	0.12	0.50
Antimony	0.42	0.37	0.45
Silver	0.35	0.10	0.23
Copper	0.35	0.28	0.31
Gold	0.35	0.24	0.31
Tungsten	0.32	0.19	0.35
Nickel	0.18	0.06	0.30
Cobalt	0.18	0.20	0.21
Iron	0.18	0.26	0.32
Rhodium	0.18	0.00	0.00

We thus find that although there is a general tendency of overvoltage to decrease with increase of valency, it is utterly impossible to find any absolute connection between the two. Thus, to take one example:—

Cadmium, with a valency of two, has the same overvoltage, 0.50, as antimony, with a valency of three or five.

Hence we must conclude that the deduction of the formation of unstable hydrides on the asumption that the overvoltage of a metal is directly related to its valency is untenable.

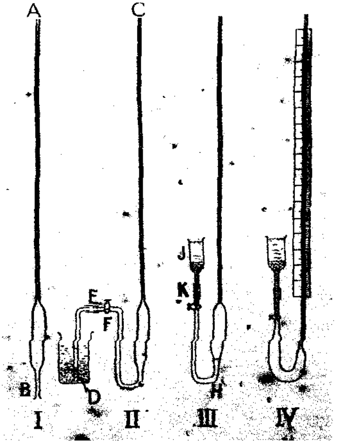
In a further paper it is hoped to show that the overvoltage of a metal is related to its other properties, but only in a qualitative way.

Sir John Cass Institute, Aldgate.
May 19, 1924.

A DILATOMETER FOR USE WITH A VERY UNSTABLE COMPOUND.

By J. Hume, B.Sc., A.I.C.

A dilatometer of the type shown diagramatically in Fig. I. was used for a determination on crystals which were very unstable, and had to be kept at 0° until the experiment was started, as they were expected to change in composition a little above the freezing point of water. The dilatometer was charged with crystals through B, which was then sealed off in a flame, the bulb all the time being surrounded with ice. The filling was completed by connecting A to a filter-pump evacuating the apparatus, and allowing liquid to enter. It proved to be extremely difficult to get all the air bubbles out of the dilatometer, and the time spent on charging was, consequently, very long. Every time the apparatus was used, on completion of the charging, it was found that decomposition of the crystals had set in, and the experiment was completely spoilt. The heating of B to seal off, the evacuation of the dilatometer, and the length of time spent on charging, all seemed to contribute to the destruction of the compound.



Consequently, a dilatometer of another ·ype was made (Fig. II.). Attempts were nade to fill this one by attaching a tube at Ǝ and making it dip into a mixture of the rystals and liquid. C was then connected o a filter-pump, and stop-cock, F, opened. The liquid quickly filled the bulb, but the irst of the crystals to enter packed tightly n D and prevented the remainder from eaching the bulb.

The next type tried is shown in Fig. III. ıt K *a funnel*, J, *supported in an upright* osition, was attached. The funnel was illed with crystals and liquid. The crysals were allowed to settle in the funnel beore the stop-cock was opened, so that plenty of crystals might enter. When the top-cock was opened, the crystals and iquid flowed freely, till crystals reached H. There they packed in a solid mass, and hoked the tube completely.

Another dilatometer, as shown in Fig. V., was made, and with this type all the ifficulties were overcome. This one was illed in the same way as that in Fig. III., ut, in this case, there was no narrow bend n which the crystals could stick. The hape is convenient for the immersion of he bulb *and funnel in ice and water during* lling. To provide a scale a metre-stick as wired to the capillary tubing.

The University, Leeds.
May 17, 1924.

THE CONSTITUTION OF THE THIONIC ACIDS.

ERRATA.

The Chemical News dated May 30.

Page 343, line 9 from the bottom, col. 1:

or

	$Na_2S_2O_6$	K_2S_{26}	BaS_2O_6	$H_2S_2O_6$
Δ =	135.6	154.1	139.5	166.0
	−Na 49.2	−K 70.6	−Ba 64.0	−H 69.5
$_2O_6$	86.4	83.5	75.5	96.5

ead:

	$Na_2S_2O_6$	$K_2S_2O_6$	BaS_2O_6	TlS_2O_6
Δ =	135.6	154.1	139.5	166.0
	−Na 49.2	−K 70.6	−Ba 64.0	−Tl 69.5
$_2O_6$	86.4	83.5	75.5	96.5

Page 344, line 19, col. 2: for "The formula for thiosulphuric acid is given as

$$\left[\begin{array}{ccc} O & & O \\ & S & \\ O & & O \end{array}\right] \begin{array}{c} H \\ H \end{array}$$

read: "The formula for thiosulphuric acid is given as

$$\left[\begin{array}{ccc} O & & O \\ & S & \\ O & & S \end{array}\right] \begin{array}{c} H \\ H \end{array}$$

Line 25, col. 2: for "hence the formula for tetrathionic acid is:

$$H_2\left[\begin{array}{ccc} O & & O \\ & S & \\ S & & O \end{array}\right]$$

read: "hence the formula for tetrathionic acid is:—

$$H_2\left[\begin{array}{ccc} O & & O \\ & S & \\ S & & O \end{array}\right]_2$$

British Empire Exhibition.

PARTICULARS OF EXHIBITS.

(*Concluded from Page* 347.)

BURROUGHS WELLCOME & COMPANY have no fewer than four separate exhibits.

The main exhibit is admirably fitted in design and colour to emphasise those ideals of purity and quality which are notably associated with "tabloid" products, with the firm's fine chemicals and medicinal preparations. This note of quality is repeated in the beautiful display of crystals and by the original and handsome design of the glassware in which many of the products are shown.

The immense quantity of raw material necessary for the production of the exceptionally pure and highly concentrated

"Wellcome" Brand Insulin Hydrochloride and the intricate stages in the production of "Wellcome" Brand Insulin, as issued, are very strikingly demonstrated in a special exhibit.

Naturally "tabloid" medical equipment are given prominence, and the unique position Burrough Wellcome & Company hold in having equipped every expedition of importance since the days of Stanley is well brought out by the display of historical medical equipments, including that carried by Stanley through "Darkest Africa," that carried to the South Pole by Scott, and that carried to the North Pole by Peary. As an example of the firm's medical equipments for naval and military expeditions, the historical case supplied to the hospital ship "Maine" is also shown.

The compactness and portability of these "tabloid" medicine cases, in view of the quantity of their contents, is a point which is obvious to the eye, but as a *tour de force*, *demonstrating the wonderful skill in manufacture* attained by long study and experience, the smallest medicine case in the *world, with its twelve phials each containing* perfectly compressed "tabloid" products, will reward attention. It measures *but ⅝ of an inch on its longest side.* A duplicate of this triumph of compression will be found in H.M. the Queen's Dolls' House *in another part of the Exhibition.*

The "Wellcome" Materia Medica Farm has an exhibit to itself, consisting of a *most interesting display of living medicinal* plants from the firm's farm at Dartford, together with a collection of herbarium specimens.

"Kepler" malt products are shown in another exhibit attractively arranged and *decorated in the Egyptian style.*

"Tabloid" photographic chemicals are utilised to make a very striking display of Buroughs, Wellcome & Company's activities. A feature of this exhibit are the beautiful and bold examples of the results obtainable with these products. A fine view by the official photographer of the Mount Evorest Expedition and a picture of Commander Wild taken in the crow's nest of Sbackleton's ship, are not only bold and arresting pictures, but emphasise the value of "tabloid" chemicals for difficult and important work. A giant "Wellcome" calculator enables all visitors to this exhibit instantly to ascertain the correct exposure for the day and hour.

WALPAMUR CO., LTD.

The company's stand has been arranged to display the result of the application of the company's specialities, viz.: Walpamur water paint, Muromatte flat oil paint, Duradio gloss paint, Mirabol enamel, Yeoman varnish, etc., etc., and the scheme has been arranged for the space at their disposal to be dealt with so that it shall represent as far as possible a portion of the great hall of an old English country home, and is decorated in a practical manner to show how the modern small home of to-day, as well as the great houses of the past, lend themselves to decorative treatment by the paints, etc., mentioned above.

JOSEPH CROSFIELD & SONS, LTD.

The stand of Messrs. Jos. Crosfield & Sons, Ltd., of Warrington, displays in an attractive setting the various forms of the half-dozen or so "Pyramid" brand chemicals, which are available to-day in the same high standard of quality for which this trade mark has long been noted. The products find application in almost every branch of industry, and special descriptive pamphlets detailing the proven uses of Messrs. Crosfield's products are distributed from the stand. Caustic soda is shown in solution, solid lump, powder, flake and stick form, and its uses are legion. In soap-making, paper-making, in the treatment of textiles, animal, vegetable and coal-tar oils, in artificial silk manufacture, in the production of fine chemicals and dyestuffs, for use in safety helmets, and as a laboratory chemical, and for many other purposes, caustic soda is an essential chemical.

The familiar use of water glass for preserving eggs must not obscure the value of *silicate of soda in a score of ways. It is an* adhesive of ever-growing importance, and is used in making cardboard and paper, abrasive wheel manufacture, and as a detergent in soap-making. It is employed to render concrete roofs and floors hard and dustless, as well as in the construction of roadways. Many other industries use silicate of soda, which is available in many types of solution to meet specific requirements.

Doucil is a base-exchanging material specially suitable for water-softening purposes, and a model domestic apparatus containing Doucil is displayed. Doucil is also valuable as an absorbent for solvent vapours and for filling electric batteries.

Carbosil, an important detergent, water softener and aluminium cleanser, has many advantages over the ordinary alkalies.

Finally, glycerine is shown as chemically pure glycerine (one of the few really pure chemicals in industry to-day), dynamite, industrial white, pale straw and crude glycerines. These products find a very extensive application in pharmaceutical and toilet preparations, explosives manufacture, food and beverage preservation, lubrication, textile treatment, copying inks and duplicating compositions, anti-freeze and anti-dimming preparations, leather dressing and polishing, and in many other ways.

The tasteful display should be seen, and special enquiries made with regard to the many uses of these high quality chemical products.

BRITISH EMPIRE EXHIBITION (1924).

Fiery Fountain.

In the centre of the scientific exhibit is the fiery fountain, an attractive scientific toy which will probably interest the general public more than the other exhibits of more scientific importance displayed in this section.

It is not possible for the general visitor to appreciate the extraordinary importance of the contributions made by the British men of science to the progress of chemical science during the last generation; to do so requires a scientifically trained mind, and it is to the instructed visitor from home and other parts of the Empire, and from foreign countries, that we look for appreciation and understanding.

It is indeed an exhibit of great significance to the instructed visitor, on account of its wide range, and of the extraordinary importance in the history of science of many of the discoveries illustrated.

But everybody can appreciate a pretty, ingenious toy, depending for its effect on the skilful application of science.

Issuing from a rock is a stream of water, flowing in a graceful curve on to a glass flower and thence overflowing into a mossy pool. As the stream of water touches the flower it appears to catch fire and the flower is brightly illuminated by fiery water. As you look, the colour changes from fiery white to fiery red, from fiery red to the vivid green like that shown by a Verey light, but the water flows over the flower entirely colourless. As it falls on to the tank below it again shows a brilliant iridescence.

Many pretty experiments have been shown with phosphorescent and fluorescent substances. Most of these depend for their full effect on a darkened room. Here we have daylight, and no doubt many besides the general public will be puzzled to know how this pretty and attractive effect is obtained.

The exhibit has been prepared by the Manchester College of Technology. A good deal of work and a good number of experiments have been made to bring this device to perfection, and Principal Mouat Jones and Mr. Hodgson are to be congratulated on providing a very successful and ingenious attraction.

Dr. T. A. Henry and Professor F. L. Pyman.

Alkaloid Section.

The ordinary visitor to the Exhibition will find the alkaloid section mysterious. It consists of a large number of little bottles containing crystals and powders of all kinds and colours, and interspersed among the bottles are cards with chemical hieroglyphics inscribed on them. But he must not run away with the idea that these things have no meaning for him. The mere term alkaloid is probably unfamiliar to him, and the explanation that it is an alkali-like substance will hardly add to his enlightenment. Yet from an early stage of his existence to its termination he is constantly making use of these things without knowing it.

If his advent into the world took place under conditions of twilight-sleep, it was under the influence of two alkaloids—hyoscine and morphine—and he can see the former occupying a whole shelf of one of the cases, to illustrate a research too abstract for explanation here.

He is almost sure, at one time or another, to have had atropine or some other tropeine applied to his eye, and he will be a lucky man if he has never had a tooth extracted under the influence of some local anæsthetic, such as β-eucaine. These are are alkaloids. Much research work has been done in England with a view to finding out how these things act and how they can be improved, and these bottles on the tropeine and β-eucaine shelves, with their explanatory diagrams, tell a fascinating story to those who can read them, and the practical

applications of these and similar researches have, among other things, made surgery feasible in directions undreamt of 50 years ago, and have contributed in no small degree to the welfare of humanity.

A more familiar alkaloid is quinine, of which several million ounces are made and sold every year, and without which life in the tropics would be impossible for the white man. All these will be sufficient to show that alkaloids are of great practical importance.

To the chemist, however, they make quite a special appeal. His object in life is to find out how things are built up from atoms of the elements or primary substances, and as alkaloids are amongst the most complicated compounds known, they present to the chemist difficult and therefore fascinating problems, first of all in taking them to pieces to find out how they are built up, and finally inventing methods of producing them in the laboratory.

The diagrams with their mysterious hieroglyphics, shown in these cases, each tell the story of how much has been achieved in these two directions for each alkaloid dealt with. Thus, one of them shows how it is possible to start with a component of nutmeg oil, and passing from it through a whole series of compounds with very long names, to arrive at alkaloids such as cotarnine and hydrastinine, which have important medical applications as styptics (*i.e.*, substances which will stop bleeding) and from these in turn to produce even more complicated alkaloids with new properties.

Apart from these medical and chemical aspects of alkaloids, they are not without interest in other directions. Thus, the exhibit includes a comprehensive series of the highly poisonous alkaloids obtained from the aconites of Japan, India and England. Aconite roots have been used as arrow poisons as well as in medicine, and they owe their use in these directions to the toxic alkaloids they contain.

Finally, it may be of interest to add that the specimens shown represent work done wholly in Great Britain, that practically every type of alkaloid is included—a sure sign of the importance of the British contribution to knowledge on this subject—that every important British authority on alkaloids has contributed to the exhibit, and that no such collection has ever been got together before.

Dr. T. A. Henry and Professor F. L. Pyman.

Section on the Constitution and Synthesis of Alkaloids.

This section is arranged in groups according to the constitution of the principal classes of alkaloids. It is fully representative of the important work done in Great Britain on this subject during the last thirty years.

It includes in the *tropane group* a selection of the synthetic tropeines prepared by Jowett and Pyman in the course of their work on the correlation of chemical constitution with mydriatic action and a comprehensive series of specimens illustrative of King's work on the deracemisation of hyoscine and of its hydrolytic products, oscine and tropic acid, an investigation which has had an important bearing on the determination of the constitution of hyoscine.

In the *isoquinoline group*, which has attracted much attention from British chemists, the work of Dobbie and Lauder on corydaline, that of Perkin on berberin and crytopine, and of Pyman on neo-oxyberberine and the methyl-canadines is illustrated by an extensive series of specimens and diagrams. In the simpler members of this group, Pyman's investigation on the reduction products of papaverine and the oxidation productions of laudanosine, with Hope and Robinson's work on the synthesis of *iso*gnoscopine, are all represented. The last-mentioned piece of research is part of a whole series of syntheses which, with Salway's preparation of cotarnine from myristicin, Pyman and Remfrey's conversion of cotarnine into hydrastinine, and Perkin and Robinson's syntheses of narcotine (gnoscopine) from cotarnine and meconin, form an interesting demonstration of the interrelationships of this subgroup of the *iso*quinoline alkaloids.

Of special importance are the exhibits shown by Perkin and Plant and Clemo and Perkin on synthetic work on tetrahydroquinoline and tetrahydrocarbazole derivatives, and finally the progress so far achieved in the direction of the synthesis of the important alkaloid, *strychnine*.

In the *glyoxaline group*, the jaborandi alkaloids, pilocarpine, *iso*pilocarpine, and their allies, and the degradation products obtained by Jowett and Pyman in the course of their work in these bases, are the

most important features of a very complete series of specimens.

Of the numerous other alkaloids of known structure shown, mention may be made of galegine, the constitution of which has been determined by Barger and White, and the synthetic alkaloids, β- and *iso*-β-eucaine, both recently deracemised by King.

There yet remain many alkaloids whose constitution is undermined or only partly determined. Among these may be mentioned (1) physostigmine, or eserine, and the other alkaloids of calabar bean, on which pioneer work was done by Salway, *and of which physostigmine is now under* investigation by Barger and Stedman.

(2) The aconite alkaloids represented here by an extensive series showing the bases and their derivatives obtained by Dunstan, Andrews, Carr and others, from English, Japanese and Indian species of aconitum and the products of oxidation of aconitine obtained and investigated by Barger, Brady, Carr and Field.

(3) The alkaloids of ipecacuanha, pioneer work on which was done by Paul and Cownley, and whose interrelationships have been determined by the more recent work of Carr and Pyman.

(4) The interesting alkaloid, yohimbine or quebrachine, on which Barger and Field are at work.

Alkaloids make a special appeal to chemists because of the fascinating problems presented by the determination of their structure and the methods by which they may he synthesised, but it must not be forgotten that they are of no little importance commercially. Most of them are used in medicine, and their manufacture is an important part of the British fine chemical industry. Much of the work referred to above, recondite as it may seem to be, has had very important bearings on the use of these alkaloids in medicine, on the possible synthesis of new drugs, and on improvements in the commercial production of alkaloids and allied substances.

PROFESSOR F. G. DONNAN.

Inorganic and Physical Chemistry Section.

Name of Exhibitor, Adeney, Prof. W. E., Dublin: *Title of Exhibit*, Apparatus illustrating rate of solution of gases by water, and rate of absorption of dissolved oxygen by sewage polluted waters.

Allmand, Prof. A. J., King's College, University of London: Apparatus for oxygen estimation and micro-gas analysis; photochemical cells, and glass-metal vacuum joints. Specimens of Solutions of chlorine in various aqueous salt solutions; electrolytic manganese; effect of colloids on metals prepared by chemical displacement from solution.

Bassett, Prof. H., University College, Reading: *Model, curves and specimens illustrative of phase rule.*

Briggs, Dr. S. H. C., Croft Villa, Gomersal, Yorks.: Specimens of inorganic compounds.

Brunner, Mond & Co., Ltt., Northwich, Cheshire (Research Department): Two *phase rule models—1, Reciprocal salt pair,* sodium nitrate-ammonium sulphate; 2, *reciprocal salt pair, sodium chloride*-ammonium sulphate; with two temperature cycles for the separation of the solids.

Egerton, Dr. A., 16, Linton Road, Oxford: Specimens of distilled metals, and curves of vapour pressure measurements.

Fairbrother, Dr. F., University, Manchester: Diffusion apparatus.

Findlay, Prof. Alex., and King, Dr. George, University, Aberdeen: *Apparatus* for investigation of the rate of evolution of gases from colloidal solutions.

Friend, Dr. J. N., Municipal Technical School, Birmingham: Specimens showing corrosion of metals, pigments, etc.

Garner, Mr. W. E., University College, University of London: Apparatus for production of hydrocyanic acid in gaseous explosions.

Lewis, Dr. S. Judd, The Laboratories, Staple Inn Buildings, London: 2 Sector Spectrophotometers.

Masson, Dr. Irvine, University College, University of London: Apparatus for measuring the compressibility of gases.

Myers, Dr. J. E., University, Manchester: Records and graphs of periodic chemical reactions.

Perkin, Dr. F. Mollwo, 59, New Oxford Street, London, W.C.1: Samples of oils obtained from coal, peat, South African torbanite and lignite, produced by low temperature carbonisation. Still employed with emulsified oils. Samples of original mauve and dyeings made therefrom.

Perman, Prof. E. P., *University College,* Cardiff: Diagrams of apparatus for measuring vapour pressures by statical method. Equilibrium diagrams for reciprocal salt systems.

Rideal, Dr. E. K., Trinity Hall, Cambridge: Recording hydrogen ion concentration meter for solutions. Carbon monoxide recorder. Water-gas analysis recorder.

Research Department, Woolwich: Space models showing the relation between the composition of a mixed solvent and its solvent. Power for nitrocellulose. Colour photomicrographs of cellulose, nitrocellulose, and cordites between crossed Nicols.

Royal Institution, London: Historical collection of apparatus of the late Professor Sir James Dewar.

Spencer, Prof. J. F., Bedford College, University of London: Electrometric titration apparatus.

Smith, Mr. A. E. C., University College, Southampton: Photomicrographs of the bismuth-tin system.

Young, Prof. Sydney, Trinity College, Dublin: Collection of special stillheads.

PROFESSOR J. W. McBAIN.

Colloid Section.

These exhibits illustrate some of the theoretical results obtained by British workers, but they also clearly demonstrate the close connection with industrial application and use of colloids.

Name of Exhibitor, The Stream Line Filter Co., Ltd.: *Title of Exhibit*, The filtration of colloids by the stream line filter.

Bradford, Dr. D. C.: Banded precipitates in jellies.

Thorne, Mr. P. C. L., M.Sc.: Colloidal carbons.

Clayton, Mr. Wm., M.Sc.: Emulsions.

Mardles, Dr. E.: Aeronautical dope films and doped fabrics, spun silk from cellulose ethers and esters, organosols and gels of cellulose esters, etc.

Whytlaw Gray, Dr.: Photographs showing coagulation of Zno smokes.

Hatschek, Dr. Emil: Leisgang specimens, etc.

McBair, Prof. J. W.: States of soap solutions.

Catalpo, Ltd.: Clay in raw state, colloidal clay, clay in suspension, emulsion, etc., manufactured article in dry state.

North British Rubber Co.: Rubber sols in tubes on swinging stand.

Hardy, Prof. W. F., F.R.S.: The distribution of water in a gel in relation to the H ion content. The effect of hydrogen ion content in modifying the valency law of precipitation.

Burton, Professor, Toronto: Coagulation of colloidal solution.

PROCEEDINGS AND NOTICES OF SOCIETIES.

THE ROYAL SOCIETY.

JUNE 5.

Papers read:—

J. E. LITTLEWOOD, F.R.S., and A. WALFISZ, *The Lattice-Points of a Circle.*

P. L. KAPITZA, *A Method of Producing Strong Magnetic Fields.* Communicated by Sir Ernest Rutherford, F.R.S.

V. HENRI, D.Sc., and H. DE LASZLO, *The Analysis of the Absorption Spectrum of Naphthalene Vapour: The Structure and Activation of the Molecule of Naphthalene.* Communicated by Sir Ernest Rutherford, F.R.S.

W. JEVONS, *On the Band Spectra of Silicon Oxide and Chloride, and Chlorides of Carbon, Boron and Aluminium.* Communicated by Prof. H. C. Plummer, F.R.S.

R. C. JOHNSON, *Ultra-violet Emission Bands associated with Oxygen.* Communicated by Prof. T. R. Merton, F.R.S.

SIR RICHARD PAGET, *The Nature and Artificial Production of Consonant Sounds.* Communicated by Sir William Bragg, F.R.S.

H. S. ALLEN, D.Sc., *The Band Spectrum of Hydrogen.* Communicated by Prof. O. W. Richardson, F.R.S.

THE CHEMICAL SOCIETY.

JUNE 5.

Papers read:—

The Absorption Spectra of Camphor and of Camphorquinone, by T. M. LOWRY and H. S. FRENCH.

Studies of Dynamic Isomerism. Part XVI.—Mutarotation of Beryllium Benzoylcamphor. Formation of an Addition-Compound with Chloroform. The Optical Activity of Beryllium, by H. BURGESS and T. M. LOWRY.

A meeting of the Society will be held in the Theatre of the Royal Institution (by

kind permission of the *managers*), on Thursday, June 12, 1924, at 5.30 p.m., when the Faraday Lecture, entitled *Atomism in Modern Physics*, will be delivered by PROFESSOR R. A. MILLIKAN, of the California Institute of Technology, Pasadena.

SOMERSET OIL SHALE.

Under the auspices of the Birmingham branch of the Junior Institution of Petroleum Technologists, a lecture was given at the University of Birmingham on Tuesday afternoon, May —, by Dr. W. Forbes Leslie, F.G.S., on the "Somerset Oil Shale Fields." Members of the Society of Chemical Industry (Birmingham and Midland Section) were present, as well as members and students of the coal and oil mining and mechanical engineering professions.

Dr. Forbes Leslie, having emphasised the need for cheap fuel, particularly for industrial purposes, dealt with the value of petroleum and the origin of oil shale.

Somerset shale was composed of an organic and an inorganic content. On treatment by destructive distillation it yielded oil, gas and ammonia water, and a residue called shale ash. Unlike most oil shales, those in Somerset, when freshly broken out, gave off a strong odour of paraffin. The action of solvents on the Somerset shales resembled that on American shales, a small percentage of the hydrocarbon being soluble. The sulphur content of the Somerset oil shales was about the same as that of the Scottish. Little or no pyrites was met with in the middle series of the shales, and the sulphur contained in the oil was principally in the form of thiophanes, and quite easily removed.

The nitrogen content was about 0.8 per cent., or a theoretical yield of 80 lbs. per weight ton of sulphate of ammonia. On the cube ton a theoretical yield of 160 lbs. would be obtained, or a commercial yield of 100 lbs. A return of 60 lbs. might very well, therefore, be looked for in commercial production. The amount of fixed carbon in the ash was about 20 to 25 per cent.

When an oil shale was destructively distilled, oil, gas, and ammonia water were obtained. Oil shales, with the known exception of the Montery shales of California, did not contain oil as such. Oil was obtained as a product of pyrolsis in the destructive distillation of the shale. The mother substance of oil in shale had been described by Prof. Crum Brown, who called it "Kerogen." Little information was available on the chemical composition of Kerogen, but in Scottish shales it had been found to consist of 73.05 per cent. of carbon, 10.62 per cent. of hydrogen, and 16.33 per cent. of oxygen. The oil producing substances of shale were, therefore, considered to be asphaltic pyrobitumens, and on being treated they changed into a bitumen which was largely soluble in organic solvents, and after extraction from the shale became a semi-fluid or asphalt-like substance. The decomposition or conversion of the pyrobitumen into a bitumen was not clearly understood.

The petrol in American shale oil was usually in large quantity up to and over 35 per cent. This was very high, even for the best Californian or Pennsylvanian petroleums, but it was "cracked"; that was, it contained large percentages of unsaturates, and in the refining treatment which required sulphurisation and subsequent washing in caustic soda, a large part of the unsaturates were lost. A shale spirit would change in sunlight to a straw-coloured liquid, and even to a red ruby liquid, due to decomposition of unsaturated hydrocarbons. Gums and resins might be thus precipitated, and would cause mechanical trouble in the motor-car. Consequently, it was necessary to free the spirit from all decomposable unsaturates. Scottish oils contained smaller percentages of petrol than either American, Esthonian, or Kimmeridge oils, but the Scottish oil was more largely saturated than most of these. The Somerset shale oil contained 9.9 per cent., and with the scrubber spirit the percentage was increased to about 13.9 per cent. This spirit contained no unsaturates, or only a small amount, and was "water white" on being refined, keeping its colour equal to the best petroleum oils. Their Somerset shale oils contained only 11.9 per cent. of kerosene, being the smallest percentage of the examples quoted.

Of all fractions, however, in shale oil, the most valuable were the light and heavy lubricating oils. The principal value in the Somerset shale oil was the large percentage of its lubricating fractions and the first-grade quality possessed by them. It

had 27.5 per cent. light lubricating oil, and 18.7 per cent. heavy lubricating oil. The resistance of the shale to heat had been transmitted to its lubricating oils, so that no cracking of the heavy lubricating oil took place up to 410 to 450° C.

In addition, it had the quality of "oiliness" and semi-fluidity at ordinary temperatures.

EMPIRE MINING & METALLURGICAL CONGRESS, LONDON, JUNE 3-6.

The following papers were submitted:—

SECTION A.: MINING.

Tin Mining in Malaya, by L. G. ATTENBOROUGH, A.R.S.M., M.INST.M.M.

The Rhymney Valley Compressed Air Installation, by E. L. HANN.

The Economics of Metalliferous Mining, by PROF. HENRY LOUIS and H. F. MARRIOTT.

The Ventilation of Mines, by PROF. D. HAY, B.Sc., and R. CLIVE.

Physiological Problems in Mining, by J. S. HALDANE, M.D., F.R.S.

Miners' Nystagmus: Its Prevention and Cure, by T. L. LLEWELLYN, M.D.

SECTION B.: PETROLEUM.

The Refining of Oil-Shale, by E. M. BAILEY.

Oil Transport: The Oil Tank Ship, by H. BARRINGER, M.INST.C.E.

Bulk Distribution of Oil, by SIR F. BLACK.

Petroleum Geology, by T. DEWHURST, A.R.C.Sc.

SECTION C.: IRON AND STEEL.

Railway Steels, by E. H. SANITER.

The British Cast Iron Research Association—Its Present Work and Future Outlook, by J. G. PEARCE, B.Sc.

The Iron and Steel Industry in Canada, by C. S. CAMERON.

The Iron and Steel Industry in India, by H. M. S. TUCKWELL.

Modern British Blast Furnaces, by F. CLEMENTS.

Modern Developments in the Metallurgy of Special Steels, by DR. W. H. HATFIELD.

SECTION D.: NON-FERROUS METALLURGY.

Metallurgical Education of University Rank in Great Britain, by PROF. H. C. H. CARPENTER, F.R.S.

Metallurgical Research in Government Laboratories, by J. L. HAUGHTON, D.Sc.

The Work of the British Non-Ferrous Metals Research Association, by R. S. HUTTON, D.Sc.

The Economics of the Copper, Brass and Nickel-Silver Industries, by G. W. MULLINS.

THE PHYSICS OF TEXTILE FIBRES.

One of the sessions of the Empire Textile Conference, which will be held at the British Empire Exhibition, Wembley, during Whitsun week, will be devoted to a general discussion on "Physical and Physico-Chemical Problems relating to Textile Fibres." This discussion is being arranged jointly by the Faraday Society and the Textile Institute, and it will be held on Wednesday, June 11, from 2.30 to 6.30 p.m., in Conference Hall No. 4. The introductory address will be given by Dr. W. Lawrence Balls, and the programme of 12 papers includes contributions from all the leading laboratories in Great Britain and Ireland engaged in Textile Research. Full particulars may be obtained from the Secretary of the Faraday Society, 10, Essex Street, London, W.C.2, or from the Secretary of the Textile Institute, St. Mary's Parsonage, Manchester.

CORRESPONDENCE.

SCIENTIFIC VERSE.

To the Editors of THE CHEMICAL NEWS.

SIRS,—During the past five years, I have been collecting verse, whose subject matter relates to the sciences, with the intention of publishing an anthology of this poetry. It has occurred to me that perhaps the readers of *The Chemical News* might be willing to help me in gathering together verse of this character. Therefore I am writing you this letter to ask you to insert this appeal for co-operation. Verse of all moods and forms, provided the subject matter relates to the sciences, is acceptable and desired. All contributions sent to me at Massachusetts Institute of Technology, Cambridge, Mass., will be gratefully received and duly acknowledged.—Yours, &c.,

C. E. RUBY.

12, *Broadway Kendall Square,*
Cambridge, Massachusetts.

NOTICES OF BOOKS.

Solubility, by J. H. Hildebrand, Ph.D. Pp. X. + 206. New York: The Chemical Catalog Co. 1924. $3.00.

This monograph, in the series issued by the American Chemical Society, is a study of the phenomena and problems of solubility. After explaining the general conception of solubility, the author defines the "Ideal Solution" from Raoult's vapour pressure law, stated in terms of molar fractions. The outcome of this is then traced in several chapters dealing with deviations from the law and other properties of solutions. The nature of concentrated solutions is treated more fully than was possible on the basis of the application of the gas laws to dilute solutions. Polarity, internal pressure, solvation and complexes are all considered in detail. There is a chapter on the vapour pressures of liquid mixtures, another on the mutual solubility of liquids, and one on the solubility of gases.

Several chapters deal with the solubility of solid non-electrolytes, electrolytes and metallic solutions. The final chapter discuses various related phenomena, *e.g.*, surface tension, adsorption, etc.

Apart from Rothmund's "Loslichkeit," and the recent works by Walden, there are no other treatises on this subject, and the author is to be congratulated for collecting so much important matter scattered through the literature.

The Chemistry of the Rarer Elements, by B. Smith Hopkins. Pp. VII. + 376. London: Messrs. Harrap, 39, Parker Street, W.C.2. 1923. 15s. net.

Prof. Hopkins regards the "rare elements" as "those members of the Periodic Table whose chemistry is little known. Some of these elements are so scarce that their study has of necessity been difficult; others are abundant in nature, but their development has been retarded by lack of sufficient interest; still others have only recently been discovered, and sufficient time has not yet elapsed for the mto lose the interest inherent in newness."

This definition is convenient for study, but is open to the serious objection that the discovery of a large deposit of some ore of intensive study of one occurring plentifully which then happens to find a special use, would automatically make the term "rare" a misnomer. This point is particularly emphasised in the case of tungsten, which finds very wide applications and is quite cheap, much more so than some of the "common" elements. Prof. Hopkins devotes a chapter of 30 pages to it.

The book follows a specialised study based upon the Periodic Classification of the elements. The opening chapter, on the Periodic System, forms a very interesting introductory, giving historically the developments towards the present position. Several modern tables (including Dushman's) are given, but the author's attention might be directed to the Wedge Table of Loring, given in his *Chemical Elements* (1923), which sums up modern views very adequately, and from which it is possible to deduce what elements really are rare.

It is interesting to note that many of the papers on this periodicity, from Newlands onwards, have first appeared in *The Chemical News*.

This book, which has evidently been the result of much careful compilation and revision, gives full and accurate information concerning the properties and applications of those elements usually omitted or briefly dismissed in ordinary text-books of inorganic chemistry. J.G.F.D.

X-Rays and Crystal Structure, by Sir W. H. Bragg, M.A., D.Sc., F.R.S., and W. L. Bragg, F.R.S. Pp. VIII. + 322. Fourth Edition. London: G. Bell & Sons, Ltd., York House, Portugal Street, W.C.2. 1924. 21s. net.

So much has been accomplished recently in the study of Crystal Structure and X-Ray Spectra that the appearance of the present edition of this important work is very welcome.

The development of Laue's observation that X-rays can be diffracted by crystals in the same way that light is diffracted by a diffraction grating, are now so extensive that a new branch of science has arisen. This is largely due to the work of the present authors; indeed, any volume on this subject must necessarily be a recapitulation of their monumental researches in this

The authors have intended that the book shall be of service to students as well as to advanced workers. This has undoubtedly enhanced its value.

The Electron in Chemistry, by SIR J. J. THOMSON, O.M., F.R.S. Pp. 144. London: Chapman & Hall, 11, Henrietta Street, W.C.2. 1924. 10s. 6d. net.

The recent extraordinary advances in our knowledge of the structure of the atom, following largely upon Sir J. J. Thomson's own investigations on the cathode and the positive rays, have tended to draw physical and chemical sciences closer together. In the near future, further developments, especially on the chemical side, may be confidently anticipated; in which case this account of the electron and its significance in chemistry is of value in presenting to chemists the present position on the subject, including, as it does, much new matter.

The matters dealt with include the following: The arrangement of electrons in atoms; stability; periodic law; allotropy; the ionisation potential; the electron theory of valency; arrangement of electrons in octets; residual affinity; molecular compouuds; Werner's theory; electrolytic dissociation; mechanism of combinations; active molecules; Thiele's theory; Keto-enol change; production of light; homologous elements; variable valency; paramagnetism; diamagnetism; solids; crystals; vibration of electrons in crystals; compressibility; surface tension; intermetallic compounds.

Altogether, this monograph, which gives a graphic account of the investigations carried out in this country, is very stimulating and will be very widely read.

Die Technische Chloralkali-Elektrose, von DR. J. BILLITER. Pp. VII. + 79. Dresden & Leipzig: Verlag von Theodor Steinkopff. 1924. 2.50 marks.

Dr. Billiter's volume is the second of the series on chemical technology published under the editorship of Prof. Rassow. These monographs are designed to indicate the trend of recent advances in that branch of technology with which they are concerned. ... with the modern manufacture of chlorine, caustic alkali, hypochlorite, chlorate and perchlorate.

It is obvious that a thorough study of the recent literature has been made, and the book will be of considerable interest to those engaged in the alkali industry.

BOOKS RECEIVED.

A Course of Instruction in Instrumental Methods of Chemical Analysis, by WILLIAM N. LACY. Pp. VII. + 95. London: MacMillan & Co., Ltd. 1924. 7s. net.

Chemistry of the Rarer Elements, by B. SMITH HOPKINS. Pp. VII. + 376. London: Messrs. Harrap, 39-41, Parker St., W.C.2. 1923. 15s. net.

The Brotherhood of the Rosy Cross, by ARTHUR EDWARD WAITE. Pp. XXIII. + 649. London: William Rider & Son, Paternoster Row, E.C.4. 1924. 30s. net.

Report of the Sixteenth Meeting of the Australasian Association for the Advancement of Science, Edited by W. R. B. OLIVER, F.L.S., F.Z.S. Pp. IV. + 872. Wellington: W. A. G. Skinner. 1924.

Complex Salts, by WILLIAM THOMAS, B.A., M.Sc., &c. Pp. XI. + 122. 1924. Messrs. Blackie & Sons, Ltd., 50, Old Bailey, London, E.C. 10s. net.

Chemical Synthesis, by HARRY HEPWORTH, D.Sc., F.I.C. Pp. XX. + 243. 1924. Messrs. Blackie & Son, Ltd., 50, Old Bailey, London, E.C.4. 20s. net.

PUBLICATIONS RECEIVED.

Nitrate Facts and Figures, 1924, compiled by A. F. BRODIE JAMES, F.S.S. London: Fredc. C. Mathieson & Sons, 16, Copthall Avenue, E.C. Price 5s.

U.S. GEOLOGICAL SURVEY.

Gold, Silver, Copper, Lead and Zinc in Nevada in 1922—Mines Report, by C. C. HEIKES. Pp. 305 to 389.

Iron Ore, Pig Iron and Steel in 1922, by ERNEST F. BURCHARD and HUBERT W.

DAVIS. Pp. 341 to 376.

The Lower Gila Region, Arizona, by CLYDE P. ROSS. Pp. XIV. + 237.

Surface Water Supply of the United States, 1919 and 1920. Part XI.—Pacific Slope Basins in California, by NATHAN C. GROVER, H. D. MCGLASHAN, and F. F. HENSHAW. Pp. VII. + 456.

BULLETINS ISSUED BY THE U.S. DEPARTMENT OF COMMERCE.

Signals, by CHESTER SNOW. Pp. 231 to 261.

Elimination of Waste. Pp. 6.

Elimination of Waste. Simplified Practice. Pp. 7.

Spectroradiometric Analysis of Radio Standards for Electric Service. Pp. 344.

DEPARTMENT OF COMMERCE, BUREAU OF STANDARDS.

Recommended Specification for Quicklime and Hydrated Lime for use in the Manufacture of Sand-Lime Brick. Pp. 7.

Dyanmpmeter Tests of Automobile Tyres, by W. L. HOLT and P. L. WORMELEY. Pp. 560 to 579.

A Comparison of the Deoxidation Effects of Titanium and Silicon on the Properties of Rail Steel, by GEORGE K. BURGESS and G. WILLARD QUICK. Pp. 581 to 635.

Stresses in a Few Welded and Riveted Tanks tested under Hydrostatic Pressure, by A. H. STANG and T. W. GREENE. Pp. 645 to 666.

A Measure of the Colour Characteristics of White Papers, by R. E. LOFTON. Pp. 667 to 676.

Embrittlement of Malleable Cast Iron resulting from Heat Treatment, by LESLIE H. MARSHALL. Pp. 677 to 693.

DEPARTMENT OF THE INTERIOR, BUREAU OF MINES.

Analytical Methods for Certain Metals, by R. B. MOORE and S. C. LIND, J. W. MARDEN, J. P. BONARDI, C. W. DAVIS and J. E. CONLEY. Pp. XVIII. + 325.

An Investigation of Powdered Coal as Fuel or Powder-Plant Boilers, by HENRY KREISINGER, JOHN BLIZARD, C. E. AUGUSTINE and B. J. CROSS. Pp. V. + 92.

Analyses of Samples of Delit with a chapter on *The Tidewater Pool Classifications*, by NED H. SNYDER. Pp. 174.

Accidents at Metallurgical Works in the United States during the Calendar Year 1922, by WILLIAM W. ADAMS. Pp. 81.

Metal-Mine Accidents in the United States during the Calendar Year 1922, by WILLIAM W. ADAMS. Pp. V. + 71.

Origin of Certain Rich Silver Ores near Chloride and Kingman, Arizona, by EDSON S. BASTIN. Pp. 17 to 39.

Manganese and Manganiferous Ores in 1922, by H. A. C. JENISON and H. M. MEYER. Pp. 585 to 593.

The Occurrence of Ground Water in the United States, with a discussion on Principles, by OSCAR EDWARD MEINZER. Pp. XI. + 321.

Summary of Hydrometric Data in Washington, 1878-1919, by GLENN L. PARKER and LASLEY LEE. Pp. VII. + 368.

The Salton Sea Region, California, by JOHN S. BROWN. Pp. XV. + 292.

Legal Weights (in Pounds) per Bushel of various Commodities. Pp. 1 to 18.

United States Government Specification for Numbered Cotton Duck. Pp. 4.

Recommended Specification for Ceramic Whiting. Pp. 7.

Wet-Process Enamels for Cast Iron, by R. R. DANIELSON and H. P. REINECKER. Pp. 695 to 735.

A New Electric Telemeter, by BURTON MCCOLLUM and O. S. PETERS. Pp. 737 to 777.

Exposure Tests on Colourless Waterproofing Materials, by D. W. KESSLER. Pp. 33.

Thermal-Conductivity Method for the Analysis of Gases, by P. E. PALMER and E. R. WEAVER. Pp. 35 to 100.

Central District Bituminous Coals as Water-Gas Generator Fuel, by W. W. ODELL and W. A. DUNKLEY. Pp. V. + 92.

United States Government Specification for Lubricants and Liquid Fuels and Methods for Testing. Pp. VI. + 89.

United States Government Specification for Titanium Pigment, Dry and Paste. Pp. 11.

Summary of Technical Methods for the Utilisation of Molasses. Pp. 72.

Equaliser Apparatus for Transverse tests of Bricks, by H. L. WHITTEMORE. Pp. 107

Messrs. F. E. Becker have issued the 23rd edition (1924) of their Catalogue of Chemical Apparatus. It contains some remarkably fine coloured illustrations of their renowned balances, which have recently dropped in price, and are now obtainable at comparatively small increases on the pre-war prices. The other apparatus listed is also worthy of the notice of those concerned with the equipping and maintenance of laboratories.

The Castner-Kellner Alkali Co. have issued four pamphlets, entitled: "Chlorine and Chlorine Products in relation to Public Health," "Sodium Perborate," "Bleaching Agents containing Chlorine," and "Electrolytic Caustic Soda in Stick Form," all of which will be found of interest to chemists and those who have occasion to use these products.

The brochure, "Foresight in Photography," issued free by Burroughs Wellcome & Co., is particularly topical. On the cover is a blue-toned photogravure reproduction of Commander Wild in the crow's nest of Sir E. Shackleton's ss. *Quest*, and throughout the text pages the smack of the sea is continued as we read how modern scientific methods of navigation and photography follow similar methods of precaution as guides to the harbour of success.

New Patents.

This list is specially compiled for The Chemical News by Messrs. Rayner & Co., Registered Patent Agents, of 5, Chancery Lane, London, from whom all information relating to Patents, Trade Marks, and Designs can be obtained gratuitously.

Latest Patent Applications.

10435—Badische Anilin & Soda-Fabrik.—Process for transforming oxides of carnon into organic compounds. April 28.
10699—Wittig, A.—Method of extracting vanadium. April 30.
11326—Bonhote, G.—Manufacture of aryloxynaphthyl-ketones. May 7.
11032—Goldschmidt Akt-Ges., T.—Production of sulphur. May 5.
11609—Plauson, R.—Production of lead acetate. May 10.
11109—Smith, S. C.—Conversion of lead sulphate into lead carbonate. May 5.

Specifications Published this Week.

204489—Bhopal Produce Trust, Ltd., and Fraymouth, W. A.—Processes for obtaining oxalic acid or its salts.
214836—Cassella & Co., Ges. L.—Manufacture of p-dialkylaminoaryl-phosphinous acids.
214917—Merck, W. E., Merck, K., Merck, L., Merck, W., Merck, F., Wolfes, O., Maeder, H.—Process of manufacture of synthetic l-cocaine.

Abstract Published this Week.

213195—Charcoal, alkali sulphides.—Akt-Ges fur Anilin-Fabrikation, S.O. 36, Berlin.

Active charcoal is produced together with alkali sulphides by impregnating wood or other cellulosic material with alkali bisulphate or a mixture of alkali sulphate and ammonium sulphate, carbonising at above 500° C., and washing the product. In examples, wood is impregnated with a concentrated solution of sodium bisulphate or of sodium and ammonium sulphates.

Messrs. Rayner & Co. will obtain printed copies of the published specifications and abstract only, and forward on post free for the price of 1s. 6d. each.

NOTICES.

EDITORIAL.—All Scientific and Technical communications for publication, and also all Books, Chemical Apparatus, &c., for Review or Notice to be addressed to the EDITORS.

SUBSCRIPTIONS £1 10s. per annum, payable in advance, should be addressed to the MANAGER.

BACK NUMBERS and VOLUMES can be purchased on application to the MANAGER.

THE CHEMICAL NEWS,
97, SHOE LANE, LONDON, E.C.4.

All Advertisements up to Tuesday for current week's publication should be forwarded to the ADVERTISEMENT MANAGER, *The Chemical News*, Limited, 97, Shoe Lane, E.C.4.

All Cheques and Post Office Orders should be crossed "The Westminster Bank, Limited," made payable to the order of *The Chemical News*, Limited, and addressed to the MANAGER, *The Chemical News*, 97, Shoe Lane, London E.C.4.

THE CHEMICAL NEWS,

VOL. CXXVIII. No. 3348.

THE ESTIMATION OF CALCIUM, MAGNESIUM, POTASSIUM AND PHOSPHORIC ACID IN GRAIN AND FEEDING STUFFS.

By Robert Gilmour.

The procedure described below has been found a rapid and convenient method of estimating calcium, magnesium, potassium and phosphate in small quantities of materials such as:—Malt wort, yeast, grain and feeding stuffs generally.

The accuracy is round about ± 1 per cent., except in the case of potassium. In this instance the volatilisation of the chloride when igniting off ammonium salts, gives rise to some loss. No doubt, conversion into sulphate before the ignition, and the use of platinum vessels for this operation, would increase the accuracy attainable.

Briefly the procedure is as follows:—

The ashing is carried out in the presence of a known amount of added magnesium in the form of nitrate; the quantity added being in excess of that necessary to bind any acid phosphates present.

The solution of the ash in hydrochloric acid is adjusted to a pH of about 4.0; calcium is precipitated as oxalate and estimated by titration with permanganate.

The filtrate throws down ammonium magnesium phosphate on making alkaline with ammonia, and magnesium and phosphate in the precipitate are estimated volumetrically.

Addition of ammonium phosphate to the second filtrate throws down the excess magnesium as ammonium magnesium phosphate, and the magnesium in the precipitate is estimated volumetrically.

The first precipitation gives the phosphate in the ash. The difference between added magnesium and the total magnesium found in the first and second precipitates, represents the magnesium in the ash.

Excess phosphate and oxalate are then removed from the last filtrate, by means of barium chloride and ammonium carbonate. The filtrate is concentrated, ammonium salts ignited off, and potassium estimated in the residue by the cobaltinitrite method.

The method outlined may be classed as semi-micro, and is suitable when from 5 to 50 milligrams of the various elements are to be estimated.

Details of Procedure:

25 cc. of a malt or grain wort is evaporated in a silica basin, with the addition of 1 cc. of a solution of magnesium nitrate, containing 10 milligrams of magnesium per cc., or similar exactly known amount. The evaporation is conducted at first on a steam bath, and later in a hot air oven at about 90° C. The thick syrup is then carefully heated over a small flame until completely charred. This can be accomplished without the mass frothing out of the basin if care is exercised, and the flame occasionally applied to the upper surface of the material. When charring is complete, the basin is transferred to a muffle furnace and ignited at a low red heat until a white or light grey ash is obtained; an operation which should not require more than ten minutes.

In the case of solids, a suitable amount is weighed into the silica basin, moistened with the known amount of magnesium nitrate solution, and, after drying in the steam oven for a short time, ashed as above described.

The ash is then dissolved in 0.5 to 1.0 cc. of HCl + 2 cc. water; warming on the steam bath for a short time. The contents of the basin are washed out into a small beaker, made up to about 25 cc., and boiled for a few minutes. To the cooled solution, methyl red and dilute ammonia are added until an orange colour is developed, or until the first signs of turbidity appear. A few drops of dilute acetic acid are then added to bring the colour to a faint pink. In this way the solution is adjusted to a pH of about 4.0-4.4.

1-3 cc. of 2 per cent. ammonium oxalate is then added, and the mixture allowed to stand for 2 hours, or overnight if convenient. The precipitate of calcium oxalate is collected on a small asbestos mat.

The most convenient filtering arrangement is the Soxhlet tube, used in sugar analysis for collecting and reducing the cuprous oxide. This is provided with a small perforated platinum or aluminium disc, as a support for the asbestos, and inserted in a rubber stopper which fits the receiver. The latter is a tube about 8 inches long and 1 inch diameter.* A stopcock at the lower end, and near the top a side tube

with 3-way stopcock, which is connected with a filter pump, allows the various fil*trates and washings to be easily collected* and run off.

The calcium oxalate precipitate is washed three times with a few cc.'s of water, and by means of a wire the asbestos mat is then pushed out into a small beaker, and the tube rinsed out into the beaker with 50 cc. N sulphuric acid, followed by distilled water. The perforated disc is removed from the beaker by means of forceps and the mixture titrated hot with 0.10 or 0.025 N permanganate.

1 cc. 0.10 N $KMnO_4$ = 2.0 mg. calcium.

The filtrate and washings from the calcium precipitation are collected in a beaker, and dilute ammonia added gradually, with constant stirring, until the first signs of permanent turbidity appear. The solution is allowed to stand for a few minutes until the precipitation of ammonium magnesium phosphate is well advanced, and then a further quantity of ammonia is added.

After standing for an hour, the precipitate is filtered off on a mat of paper pulp washed three times with 5 cc. of 2½ per cent. ammonia and then with four 5 cc. lots of neutral rectified spirit.

The mat containing the precipitate is transferred back to the same beaker, stirred up with a convenient amount of $\frac{N}{10}$ soda until the colour is the same as that of a standard acetate solution of pH 4.6. It is convenient to take 2 cc. of the standard acetate solution, introduce it into a beaker of the same size as that used for the titration, make up to approximately the same volume as the solution titrated, and add the same amount of methyl red to each.

Each cc. HCl used = 4.75 mgr. PO_4.

Each cc. HCl used = 1.20 mgr. Mg.

The filtrate and washings (except alcohol) are then run into a beaker, and about 4 cc. of 4 per cent. ammonium dihydrogen phosphate added. After an hour the precipitate of ammonium magnesium phosphate is collected and titrated as described above, and the magnesium present calculated.

Then magnesium in the ash = Mg in first PO_4 precipitate + Mg in second precipitate − Mg added before ashing.

The filtrate and washings from the last operation are concentrated to about 15 cc., 2 cc. of 2 per cent. barium chloride are *added, followed by 15 cc. of saturated* ammonium carbonate in a mixture of alcohol and strong ammonia (50 per cent. by vol. of each). After standing for one hour, the solution is filtered and the filter washed several times with small quantities of the ammonium carbonate solution. The filtrate is then evaporated to dryness, and the ammonium salts ignited off; using the lowest possible temperature in order to avoid volatilisation of KCl. The ignition is not very satisfactory in silica vessels, a loss of KCl being the rule; but by conducting it in a platinum basin, with the addition of sulphuric acid to convert the KCl into sulphate, more accurate results could no doubt be obtained.

After ignition, the residue in the basin is treated with 1 cc. dilute HCl, and warmed on the steam bath. The solution is washed into a small beaker; the total volume being about 5-6 cc., or if the amount of potassium is likely to exceed 15 mgr., it is made up to 25 cc. and 5 cc. taken for analysis.

To the solution taken for analysis, a few drops of glacial acetic acid are added, followed by 3 cc. of cobaltinitrite solution. The mixture is allowed to stand for half an hour, and the precipitate filtered off on an asbestos mat, and washed with small quantities of distilled water until the washings are colourless.

Meanwhile, 25 cc. of $\frac{N}{10}$ permanganate are added to about 250 cc. distilled water in a conical flask, and the solution heated to boiling. The cobaltinitrite precipitate is transferred from the filter tube to a small beaker, and the contents of the latter washed into the boiling permanganate. Boiling is continued for about 1 minute, after which 15 cc. of 4 N sulphuric acid are added and the boiling continued for two minutes longer. After removing from the flame, 25 cc. of $\frac{N}{10}$ oxalic acid are added, and after the solution has again become clear it is titrated with $\frac{N}{10}$ permanganate

until a faint permanent pink is obtained.

Co.'s $\frac{N}{10}$ permanganate in final titration $\times$ 0.71 = *milligrams potassium.*

It is important that the decomposition of the cobaltinitrite precipitate should take place before acidification. If it takes place in acid solution the reaction follows a slightly different course, and the factor becomes 0.65 instead of 0.71.

Addition of the precipitate to the boiling permanganate followed by immediate acidification is liable to result in both forms of reaction taking place, and the factor will lie at an uncertain point between 0.71 and 0.65.

MacDougal (*J.Am.C.S.*, 1912, XXXIV., 1684) explains the reaction as follows:—

$K_2Na\ Co\ (NO_2)_6$ would require 12 oxidising units, were it not for the fact that cobalt changes from tri- to di-valent. Consequently 11 units only are required.

$$2\ K = K_2NaCo\ (NO_2)_6 = 11\ 0/2$$

$$1\ cc.\ \frac{N}{10}\ KMnO_4 = 0.000711\ grm.\ K.$$

In acid solution trivalent cobalt is not an active oxidiser, at least it will not oxidise nitrous acid, since it is in acid solution that nitrous acid oxidises di- to tri-valent cobalt. Accordingly in sulphuric acid solution cobaltic must change to cobaltous with evolution of oxygen.

$$2\ K = K_2Na\ Co\ (NO_2)_6 = 12\ 0/2$$

$$1\ cc.\ \frac{N}{10}\ KMnO_4 = 0.00065\ grm.\ K.$$

REAGENT FOR POTASSIUM.

(Kramer, *J. Biol. Chem.*, 1920, XLI., 267.)

Solution A.—50 grms. cobalt nitrate crystals in 100 cc. water + 25 cc. glacial acetic acid.

Solution B.—50 grms. sodium nitrite in 100 cc. water.

Mix 6 vols. of A with 10 vols. of B, aerate several hours to remove nitric oxide.

If kept in the dark in a cool place the reagent remains good for weeks.

As an example of the accuracy attainable with the method, the following figures may be quoted:—

(1) Solution containing Ca, Mg, K, PO_4, and Cl.

	Found.	Present.
Ca	11.86 mg.	11.84 mg.
PO_4	46.07	46.10
Mg	7.15	7.06
K	28.75	26.90
(2)		
Ca	4.2 mg.	4.0
PO_4	39.4	39.9
Mg	4.18	4.0

The following analysis of yeasts and grain may be quoted:—

Worts.	Ca	Mg	PO_4	K.	
(1)	0.086	0.019	0.135	0.278	%
(2)	0.051	0.028	0.237	0.129	
(3)	0.074	0.030	0.234	0.147	
(4)	0.068	0.025	0.211	0.195	
Yeasts (% on dry substance.)					
(1)	0.080	0.153	3.26	2.32	
(2)	0.040	0.153	5.00	2.34	
Grain, &c. (% on dry substance.)					
Yellow American Maize	0.005	0.115	0.67	0.26	
Malt culms	0.120	0.150	2.02	1.82	
Dried green malt	0.030	0.151	1.15	0.35	

I am indebted to the Directors of the United Distilleries, Ltd., for permission to publish these results.

The Laboratory,
United Distilleries, Ltd.,
Belfast.

ENGINEERS AND THE INTERPRETATION OF CHEMICAL SPECIFICATIONS FOR IRON AND STEEL IN RELATION TO ANALYTICAL ACCURACY.*

By C. H. RIDSDALE, F.I.C., F.C.S.

The work of the British Chemical Standards Movement had revealed data not available before, which should have practical bearing on the interpretation of chemi-

* *Paper read at the Technical Institute, Middlesbrough, at a Joint Meeting of the Cleveland Institution of Engineers, the Newcastle section of the Society of Chemical Industry, and the Institute of Chemis-*

cal specifications. It was not merely a matter for chemists, and already widespread interest had been taken and opinions expressed, and the views of their members were now sought.

Rejection or delay in accepting material ultimately was paid for by the consumer, and that when interpretation of specifications was unnecessarily rigid our difficulties in competing increased and the country suffered. Mr. Samuelson, in his Presidential address (*Journal of the Iron and Steel Institute*, 1922, I., 30), said: "Two railways, over whose lines many of the same trains run, vary by 0.02 per cent. for both elements;"—(phosphorus and sulphur)—"if one of these railways be not endangering the lives of its passengers, the other is needlessly increasing the cost of making steel rails, and restricting the use of certain ores."

He was not dealing with this vital question, but merely cited it to show what happened, whether rejection or delay was due to real or imagined necessity.

Bringing certain facts before them, however, was not an attempt to relax specifications, and he recognised that although foreign makers, on the whole, had more latitude allowed them, engineers, in being rigid, were aiming at maintaining a well-earned reputation for high quality and safety. They specified chemical limits which, from experience or from what metallurgists had led them to believe, they considered desirable.

For carbon manganese and silicon they usually gave an upper and a lower limit, arranged to gibe certain strength and toughness and to meet the manufacturers' unavoidable working margin, but for what were regarded as injurious impurities only a maximum limit was given, so low that its effect was negligible for the purpose.

Engineers, then, looked to the chemist to tell them whether or not the materials came within these.

The author considered one case: "S or P not to exceed 0.03 per cent." in steel, though it applied equally to other figures for ore, cast iron, or steel.

The maker, of course, wanted to work to this; he did not wish, after the material was made, to have it rejected, so he looked to the engineer not only to tell him exactly what he wanted, but to give him means for making sur eas he proceeded with manufacture that he was doing this.

For composition, however, he had nothing definite to go upon—all that was given him was a figure on paper that had no exact meaning; its value was determined arbitrarily after the steel had been made by analytical operations subject to varying personal and other factors, so that another test of the sample might yield a different result. So, although the maker's own chemist might find the material right, he could never be sure it would not be rejected.

Analytical chemistry was able to determine composition with considerable accuracy, and owing to this, and to the extremely small quantities dealt with, gauging by it was set to a very high degree of exactitude.

If chemists had not been able to test so accurately, specifications would not have been so stringent.

For the same reason exaggerated importance was apt to be attributed both to the influence of small quantities of impurities and to trifling differences in results; no allowance, however, was officially recognised for differences which analysts usually gave in practice, which were distinct from differences arising during manufacture and recognised as inevitable.

If, instead of the maker having to work to and be judged by an unfixed and unascertainable (by him) value, the composition figure was specified in terms of a definite standardised sample the values of which had already been determined, how much more satisfactory for all concerned! This would be tested side by side with the sample of steel made, and by its agreement with or divergence from its acknowledged standard figure, would at once reveal whether or not the working and results of both were correct.

It was difficult to understand why engineers did not yet, in specifications, refer their figures to such a standard now that a good range was available, and why makers did not insist on it.

Here the data referred to at first should modify our views, and clear up some of the confusion that existed as to what good work and good agreement meant.

In the preparation of standard analysed samples, important factors which tended to differences between chemists in ordinary work were removed, and there was direct proof that these measures were effective.

The chemists were men of status, using

what they regarded as the most reliable methods with the greatest care. Yet, whenever a large number (10 to 20) tested the same sample, the final carefully considered results had shown an appreciable variation.

The work of three other known movements bore this out.

In the investigation referred to, the differences were taken out for the 10 to 20 final tests for each of the 100 or more standardised results: and the averages of the differences for each element from all these showed a range of variation.

Although, no doubt, mainly due to limitations of the methods themselves and differences of judgment on the part of the chemists, clearly some of the results must be wrong, but who could say which?

In these circumstances, the question arose: was there justification for regarding any result by one, or even two or three chemists as right, except to within a similar range of variation?

Then, was it reasonable that material should be rejected solely for wrong composition, when the variation from the figure specified did not exceed that by which the reference or any chemist might be in error?

This question was in line with the essential objects for which their co-operators had undertaken the production of standards.

A reference chemist might know his results would condemn material, and though he felt convinced the small difference from specification would not be detrimental, he could not modify it.

Or a works' chemist might find himself regarded as wrong, and steel he felt certain was right, be condemned, but if the engineer was rigid, he had no redress.

These facts and considerations were submitted to the general meeting of the British Chemical Standards' Movement, held February 9, 1923, and their views embodied in

Resolution 4 (carried unanimously):—

"That as co-operators in the British Chemical Standards' Movement, we believe that it would be useful to manufacturers and users of steel, cast iron, etc., to have a definite expressed opinion as to the limits of accuracy of analytical methods usually met with in practice, as indicated by the differences found among the results obtained by different qualified chemists working on the same sample, since these which should be accepted; and we consider that the rejection of steel or cast iron is not warranted on chemical analysis alone, merely because the result found for a constituent differs from the round figure specified by an amount within the tolerances so obtained; and we request the Committee, in conjunction with the organisers: to obtain the opinion of the whole body of co-operators, and such other persons as they may think desirable, to establish a list of such limits, and to report to a future meeting of the co-operators."

In accordance with this, a circular letter and an opinion slip, duly approved by the Committee, were sent out to co-operators and users of standards, and also to a few others whose opinion would be of value—about 550 in all—comprising chemists, metallurgists, engineers, manufacturers representing iron and steel makers and users, and independent men in the British Empire and other countries, and they were asked to say whether they thought there was any more accurate and reliable way of determining "the limits of accuracy of analytical methods usually met with in practice as indicated by the differences found represent fairly the limits of difference among the results obtained by different qualified chemists working on the same sample," than by taking out such differences between the chemists in the analysis of the respective standards.

Then was given a table showing that the "Tolerances which would seem reasonable for analytical determination of composition" were really very small when compared with those actually granted for other properties of material, such, for instance, as variation in weight and of length.

Summarised and in tabular form, these are:—

Tolerances officially granted for weight and length and those proposed for composition.

For	Per cent. Plus or minus for normal conditions.	
Weight	1.0	granted, see B.E.S.A. specifications.
Length	0.05	

Composition

	Actually found under exceptionally favourable conditions.	Suggested
Carbon, up to 0.35%	0.025%†	0.015%
0.36—0.75%	0.033	0.020
0.76—1.20%	0.05	0.025

Silicon up to 0.10%	0.025	0.015
0.10—0.20%	0.032	0.020
Sulphur up to 0.08%	0.0077 (0.008)	0.005
Phosphorus up to 0.05%	0.0062	0.005
over 0.10%	0.012	0.007
Manganese		
Plain carbon steels up to 0.45%	0.021	0.015
0.46—1.0%	0.048	0.025
Alloy steels, cast Iron up to 0.7%	0.050	0.030

¦ *The percentages of variation found and suggested for composition are (as in the case of weight and length) percentages of the whole 100 units, not of the total of the particular element determined only.*

The tolerances tentatively suggested were, it would be seen, slightly above one-half the range of variation found with work under exceptionall yfavourable conditions.

A concrete example was given, which would work out in practice as follows:—

"At present, if A. makes some steel against a 0.03 per cent. specification, which on careful testing he finds contains 0.029 per cent., but the purchaser, B., finds 0.034 per cent., particularly if an independent chemist also finds 0.034 per cent., it is likely to be rejected, and considerable trouble may result. This 0.005 per cent. difference being, however, within the range of accuracy of testing, it would be quite reasonable to accept it, for it is practically certain that if, say, 10 to 15 chemists of standing tested it, several would find as low a result as A. had done."

Therefore, if the matter was viewed rationally and the tolerance clauses were generally adopted, the steel would be accepted, the steel without hesitation, and the trouble avoided.

In pointing out these matters, the British Chemical Standards' Movement Co-operators were not seeking to relax or modify the limits allowed by specification—this was no part of their business—and makers and sellers of material would be very unwise to act on such a supposition and allow themselves greater latitude in manufacture.

Out of all the 550, *not one* had objected outright to the principle, though several said the tolerances were *not sufficiently large*, or raised partial objections, all of which he gave. Two or three others said they did not feel disposed to offer any opinion. But the vast majority approved both of the principle and the amounts, many besides, such as were quoted, also had written in favour of the effect to get the matter considered.

Quite a number had written long and careful replies.

A number of replies were from prominent officials abroad, *e.g.*, India, South Africa, etc. As these contained valuable points, a summary or extracts of some of them were given, and where permission had been received the names of the writers also, as this added to the value of their remarks.

In addition to the very large number who had signified their approval merely by signing the slip, three correspondents thought all the tolerances suggested, and one those for carbon only, to be too low; whilst one thought all tolerances, and one of those for sulphur and phosphorus only, to be too high. Two expressed the opinion that the decision (as to rejection) should be left to metallurgists, one adding that chemists, if allowed to do so, would settle any differences amicably. One writer had not realised that the closeness of agreement of results in his own laboratory was something quite different from that occurring between a large number of chemists. One thought that if tolerances were adopted specifications would become more stringent, whilst another thought makers should work to lower limits.

This would seem very illogical and unfair, as "Tolerances" would only be a recognition of a state of affairs—slight uncertainty as to the exact value which had always existed. It did not mean that the steel, etc., became any more impure on that account.

They had heard the case, also what were the views of a large number of people representing different interests and schools of thought, so he wanted their views also, particularly on certain definite issues.*

The fact of these differences between

* *He had brought this matter forward because he had come across the facts, and from his independent position it would be known that he had no axe to grind. A works' chemist could not well have brought it forward, nor could he himself, pending any case on which he was engaged. He was not out to advocate anything but what facts showed to be a rational course, so he wanted their views also, particularly on certain definite issues.*

chemists, even when doing the most careful work, could not be gainsaid, and showed that they caused considerable trouble, and did not improve the status of the chemist in the eyes of engineers and commercial men.

A difference of 0.005 per cent. might look a lot as compared with a total of 0.03 per cent., but it was really only one twenty-thousandth of the unit.

Was not determination of composition to such a degree of accuracy really very fine working? And was not any idea to the contrary largely due to thinking of the figure 5 rather than of the distance it was to the right of the decimal?

They should think of it in terms of something else that they could realise better—for instance, length. Every engineer could readily visualise 1/100th of an inch. Fancy measuring 200 inches, or 16ft. 8ins. to one-hundredth of an inch! Or meauring 1,667 feet—about one-third of a mile—to 1 inch! Or, weight, weighing a ton to within 1¾ ozs.! Yet that was the equivalent of what a chemist did, and gave some idea of what a little such a tolerance amounted to.

To avoid confusing the issues, he would not discuss the question of how far such a difference in sulphur or phosphorus as 0.005 per cent., even if it were an increase, could detrimentally affect the material, when even the 0.03 per cent. specified was evidently regarded as a negligible amount for the purpose.

Another way of dealing with the matter seemed to be for chemists not to report to the third decimal place, at any rate by less than 0.005 per cent. at a time.

An engineer might say "if 0.001 per cent. or 0.002 per cent. does not really matter or you can't be sure within that, why do you report it?"

The practice, no doubt, had arisen from chemists being men of very precise habit, and when they worked out a weight or reading, their love of accuracy led them to do this; and having taken the figure to a negligible point, they had not to make up their minds whether to express the result by a higher or lower round figure. Also there was an instinctive dislike to curtailing figures. The expression in that way was, however, mathematical rather than technical.

However, if the present custom of reporting (to the third decimal point) was to be continued, would it not seem to be imperative to allow such differences as the tolerances?

And was it not for chemists rather than engineers or commercial men to define what a given figure meant, and how closely it ought to be interpreted?

If, however, they contended that figures should be reported to such a degree of fineness, and that these differences did matter—which seemed to be the view held—the only way was for chemists still further to improve their working. In that case was it not imperative that everything should be done to facilitate the desired exactitude?

To this end ought not engineers to supply, or at least refer to definite standards obtainable by all (which should serve equally as a check on the works or reference chemist's working), just as they stated the composition itself, in fact as an inherent part of and invariable concomitant with this, and ought not both makers and chemists to regard these standards not merely as a convenience to be supplied or used at option, but as a necessity which they had a right to demand?

So, too, as regarded both the choice of analytical methods and the exact way of conducting them. Whether we liked it or not, did not the facts all drive us to the conviction that for commercial purposes these must be standardised? And further—since the accuracy of all methods depended on a number of factors, very slightly different conditions affecting the result, and the more operations the more chances of variation—could we hope to get closer agreement except by mechanicalising the methods also as far as possible, for then all chemists would be working on the same lines, under the same conditions, and with the minimum of variable factors?

This was the real value of and justification for such methods rather than speed, total time saved, or economy.

Although, still to some chemists, this idea was repugnant, very many—a constantly increasing number—recognised the necessity of it and were using such methods.

Whatever might be the exact means by which the differences and difficulties referred to in this paper would ultimately be removed—it was not to be expected that it would be achieved all at once—the more the subject was ventilated and discussed between engineers, managers and chemists, the sooner would this come about.

We had as an example of evolving certain

definite lines out of the somewhat chaotic state of affairs when each engineer did as seemed good to himself, the splendid work of the British Engineering Standards Association.

True, they only made recommendations, not laws, but these were becoming more and more effective every day, and we could only expect the B.C.S. recommendations to take effect in the same way.

Might not the questions as to the interpretation of chemical specifications be similarly cleared up by engineers and chemists if they would unite on the same lines?

British Empire Exhibition.

NOTES ON EXHIBITS IN THE SCIENTIFIC SECTION.

PROFESSOR J. F. THORPE.

General Organic Chemistry.

The exhibit occupies two long benches, one on either side of the central "fire" fountain. Each bench carries a central upright rail, on both sides of which the framed exhibits are shown. The bench space is also occupied chiefly by framed exhibits, but a number of models illustrating the spatial relations of certain carbon compounds are also shown.

It is intended that each framed exhibit should tell some complete story of organic chemical research. Specimens of the compounds employed from the initial material to the finishing product are contained in small glass tubes attached to cards which bear the names and formulæ. Connecting the cards are directional arrows showing the course of the various reactions, the arrows having written on them, when necessary, the name of the appropriate reagent used.

The following is a list of the exhibits, with the names of the exhibitors:—

Prof. H. E. Armstrong and Prof. W. P. Wynne, Central Technical College, London: Reference compounds of naphthalene.

Messrs. E. de Barry Barnett, J. W. Cook, and E. P. Driscold, The Sir John Cass Institute: Anthracene derivatives.

Dr. D. R. Boyd, University College, Southampton: Stability of phosphorous esters.

Dr. O. L. Brady: Stereo chemistry of the oximes.

Messrs. R. P. Mehta, F. P. Dunn, and J. P. McHugh, The Ralph Forster Laboratory of Organic Chemistry, University College, London: (1) The four isomeric methyl esters of p-nitrobenzophenone oxime; (2) derivatives of m-nitrobenzaldoxime.

Mr. C. H. Browning and Prof. J. B. Cohen, F.R.S., with Mr. S. Ellingworth, Dr. R. Gaunt, M.Sc., and Mr. R. Julbransen, Universities of Leeds and Glasgow: Specimens illustrating researches on antiseptics.

Mr. Chaston A. Chapman: Humulene and derivatives; spinacene and derivatives.

Dr. F. D. Chattaway, F.R.S., Mr. G. R. Garton-Clemo, and Mr. J. D. Parkes, University of Oxford, The Queen's College Laboratory: (1) Relation between colour and constitution of substituted hydrazones; (2) Tetrachloroiodides of organic bases; (3) Diazonium tetrachloroiodides and plumbichlorides; (4) One formation of derivatives of oxalacetic acid from tartaric acid.

Prof. J. N. Collie, Department of Organic Chemistry, University College, London: Derivatives of α- and γ-pyrone, showing the occurrence of quadrivalent oxygen.

Messrs. W. M. Cumming and D. J. Brown, The Royal Technical College, Glasgow: Hydroferrocyanides and hydroferricyanides of alkaloids.

Dr. Charles Doree and Mr. J. Addyman Gardner, Borough Polytechnic Institute, London, and St. George's Hospital, Medical School, S.W.: Cholesterol derivatives.

Dr. H. J. H. Fenton, F.R.S., Christ's Church, Cambridge: Dihydroscymaleic acid and dihydroscylarlaric acid and derivatives.

Prof. F. E. Francis, The University, Bristol: Composition of paraffin wax.

Dr. C. K. Ingold, Organic Chemistry Department, Imperial College of Science and Technology: Synthesis of benzenoid compound through cyclobutane derivative.

Dr. J. Kenner and Messrs. G. Jackson and G. H. Christie, Chemical Department, University of Sheffield: (1) Optical activity in the diphenyl series; (2) b-phenyl glutaric acid and derivatives.

Prof. F. S. Kipping, Mr. B. D. W. Luff, and Dr. F. Challenger, F.I.C., University College, Nottingham: (1) Synthesis of d-l-silicon compounds and their resolution into their optically active components; (2) Derivatives of camphor and camphoric acid.

Prof. A. Lapworth, F.R.S., Messrs. L. K. Pearson, F. A. Royle and F. W. Wykes.

Chemistry Department, University of Manchester: Constitution of gingerol.

Dr. A. K. Macbeth and Mr. J. Mackay, United College, St. Andrew's University: (1) The constitution of glycogen; (2) the constitution of arbutin.

Dr. J. E. Mackenzie, Department of Chemistry (in relation to medicine), University of Edinburgh: Ketals of the type $(C_6H_5)_2\ C(OCH_3)_2$.

Dr. W. H. Mills, University Chemical Laboratory, Cambridge: Models illustrating the stereo chemistry of centro-asymmetric compounds, and of compounds showing enantio-morphism dependent on the presence of doubly linked trevalent nitrogen.

Dr. R. H. Pickard, F.R.S., Dr. J. Kenyon, F.I.C., Messrs. A. T. Fuller, W. O. Littlebury and L. Hall, Battersea Polytechnic: (1) Dependence of rotatory power on chemical constitution; (2) hydroaromatic and terpenic alcohols.

Prof. W. J. Pope, F.R.S., University Chemical Laboratory, Cambridge: Models illustrating the stereo-chemistry of Centro-asymmetric compounds.

Dr. F. L. Pyman, Messrs. I. E. Balaban, R. G. Fargher and L. Ravald, Municipal College of Technology, University of Manchester: (1) Aromatic character of glyoxaline derivatives; (2) tautomerism of amidines.

Prof. S. Smiles, F.R.S., and Mr. L. R. Hart, King's College, University of London: Synthesis of derivatives of oxythionaphthen.

Prof. J. F. Thorpe, F.R.S., Mr. E. H. Farmer and Dr. C. K. Ingold, Organic Chemistry Department, Imperial College of Science and Technology: Intra-annular tautomerism.

Prof. J. F. Thorpe, F.R.S., Messrs. G. R. Kon and A. Stevenson, Organic Chemistry Department, Imperial College of Science and Technology: Ring-chain tautomerism; keto-cyclol type.

Dr. M. A. Whiteley, Messrs. E. H. Usherwood and D. Yapp, Organic Chemistry Department, Imperial College of Science and Technology: Ring formation in the oximes and hydrazones of certain substituted mesoxamides.

Dr. F. J. Wilson, F.I.C., Messrs. R. Burns, A. B. Crawford, J. V. Hopper, M. M. J. Sutherland, and E. C. C. Pickering, The Royal Technical College, Glasgow: (1) Thiosemicarbazones; (2) semicarbazones and semioxamazones.

SIR WILLIAM BRAGG, F.R.S., AND PROFESSOR W. L. BRAGG.

The Analysis of Crystal Structure by X-Rays.

The exhibit, part of which is shown with the Royal Society's exhibition and part with the scientific exhibition in the Chemical Section, illustrates the application of X-rays to the analysis of crystal structure.

The whole exhibit comprises:—

(1) Two forms of spectrometer, one adapted for measurement by ionisation methods, the other by photographic.

(2) Some of the photographs obtained by the use of the latter instrument.

(3) Models representing the arrangement of the atoms in the structure of a number of crystals. Most of these are to be found in the Chemical Section: the remainder, with (1) and (2), are shown here.

One set of models represents the structure of some of the elements. All metals are crystalline, and in most cases their structures are very simple. The non-metallic elements form more complex crystals, in which the atoms are bound more tightly to some of their neighbours than to others, as the examples show.

Another set of models represents the structures of some inorganic compounds of a simple type. The two examples of dimorphism are of special interest. Calcium carbonate and zinc sulphide can each crystallise in two entirely different ways. The models show that a simple relationship exists between the two. The sizes of the balls indicate approximately the amount of space taken up by the electronic system of the atom. In the case of the compounds the ball representing the atom of the metal is coloured black, and that representing the acid radicle is coloured red.

Another set of models, shown partly here and partly in the Chemical Section, illustrates an attempt to apply the method to the study of crystals of organic substances. Their analysis cannot be carried to the determination of the position of each single atom as in the inorganic crystals, but is sufficiently sure as regards the arrangement of the molecules, and the general disposition of the atoms.

EXHIBITED BY SIR WILLIAM BRAGG.
Royal Society:

(1) Photographic spectra of long-chain molecules.

(2) Models of two long-chain molecules, on a scale of 1 to 165 million.

(3) Model of diamond.
(4) Two forms of X-ray spectrometer.
(5) X-tube.

Chemical Section:
(1) Tartaric acid. Model of structure.
(2) Racemic acid. Model of structure.
(3) Models of long-chain molecules.
(4) Models of naphthalene and anthracene.
(5) Models of diamond.

EXHIBITED BY PROFESSOR W. L. BRAGG.

Royal Society:
Models of the structures of non-metallic elements.

Chemical Section:
(1) Models of the structures of the elements.
(2) Models of the structures of inorganic compounds.
(3) Examples of dimorphism.

PARTICULARS OF EXHIBITS IN THE BIOCHEMICAL SECTION IN THE CHEMICAL HALL.

DR. H. W. DUDLEY, of the National Institute for Medical Research.

Insulin.

There will be a large jar of pickled pancreas and a specimen of crude insulin corresponding to the yield from the pancreas shown. Further specimens of picrate and hydrochloride, also corresponding to the amount of pancreas shown. There is also shown the amount of insulin required for a daily dose for an average diabetic in solid form, and photographs of a case before and after treatment.

PROF. J. C. DRUMMOND, of University College, London.

Vitamin A.

Origin of Vitamin A in cod liver oil:

The almost unique value of cod liver oil in the treatment of diseases of malnutrition is due to the presence of relatively small amounts of certain substances termed vitamins.

Researches carried out in the Biochemical Dept., University College, London, and the Lister Institute, London, have shown that the origin of these vitamins is in the microscopic marine plants, such as diatoms. These form the main food supply of small animals (plankton), which in turn are the food of larger species, squids, shell-fish, small fish. The cod feeds largely on small fish (capelan) and on squid, and stores up in its liver the vitamins which have passed through all these stages from the microscopic green plants. Specimens showing these stages are exhibited.

Preparation of Cod Liver Oil:

Originally cod liver oil was made by allowing the livers to rot in vats exposed to the air. The oil slowly formed a layer at the top, and was dark brown and a very unpalatable product. With the introduction of the steaming process about 1850, this process gradually died out, and is now nearly extinct. Modern processes are based on the heating of the fresh livers by direct or indirect steam. The oil is skimmed off from the top of the cooked mass, and is allowed to clear by settlement. This first fraction is further purified by freezing and filtration, to yield the white clean oils used to-day for medicinal purposes. Second, and sometimes third fractions may be prepared from the liver residues, but they are not usually refined, and are often employed for feeding cattle or for industrial purposes. The modern processes of preparation and refining have no appreciable effect in reducing the amount of vitamins present, nor are the very clean white oils now prepared inferior in nutritive value to the old "rotted" oils. Specimens of typical oils of each class are shown.

Chemical Nature of Vitamin A:

A series of exhibits is shown, illustrating the progress in the attempts to isolate the vitamins in cod liver oil. By a series of processes it is possible to concentrate the whole of the vitamin into one fraction representing 0.1 per cent. by weight of the original oil. The chemical nature of the components of this fraction are under examination. Apart from cholesterol, the constituents of the unsaponifiable material of cod liver oil, which contains all the vitamins, appears to consist chiefly of unsaturated alcohols of high molecular weight.

DR. S. S. ZILVA, of the Lister Institute, London.

Vitamin C.

A number of specimens showing the successive stages of fractionation of the antiscorbutic factor in lemon juice.

The starting point of a litre of lemon juice in which the specimens will contain the same potency, although there will be obviously a great diminution of the solids, the last specimen containing only 0.4 grm.

as against 90 grms. of total solids on a litre of juice.

PROF. A. R. LING and MR. D. R. NANJI, of the Brewing School, University of Birmingham.

A number of specimens of starch and its derivatives, illustrating work recently published in the *Journal of the Chemical Society*.

There is also a number of rare sugars and photomicrographs of the osazones of different sugars.

DR. E. F. ARMSTRONG, F.R.S., of Messrs. Crosfield & Sons, Ltd., Warrington.

Is showing the mechanism of—

(1) The action of fat hydrolysing enzyme or lipase.

(2) The action of sugar hydrolysing enzyme or invertase.

(3) The action of cyanogenetic glucoside hydrolysing enzyme.

JULIAN L. BAKER and H. F. E. HULTON, of Messrs. Watney, Combe, Reid & Co., Ltd., Stag Brewery, Pimlico, London.

Are exhibiting the products of the reaction of the amylase from ungerminated cereals on starch. The products formed are maltose 60 per cent., and -amylodextrin 40 per cent, The properties of the amylases from ungerminated cereals are very different to the amylases in the germinated cereals.

PROF. A. HARDEN, F.R.S., D.Sc., and R. ROBINSON, PH.D., B.Sc., of the Lister Institute.

Hexosephosphates.

When a sugar is treated with yeast juice, dried yeast, etc., in presence of an inorganic phosphate, a very rapid fermentation occurs, and hexosephosphoric esters are formed at the same time. Two such esters have been isolated, and their barium salts are here shown.

These or similar compounds are also formed in the animal organism, and probably play an important part in the processes of muscular contraction and formation of bone.

DR. A. SLATOR, of Messrs. Bass & Co., Burton-on-Trent.

Tubes illustrating the influence of air and carbon dioxide on yeast growth.

(To be continued.)

PROCEEDINGS AND NOTICES OF SOCIETIES.

THE ROYAL SOCIETY.

JUNE 5.

Papers read:—

SIR RICHARD PAGET, BART., *The Nature and Artificial Production of Consonant Sounds.* Communicated by Sir William Bragg, F.R.S.

P. L. KAPITZA, *A Method of Producing Strong Magnetic Fields.* Communicated by Sir Ernest Rutherford, F.R.S.

The possibility of obtaining strong magnetic fields for a small fraction of a second was discussed.

An accumulator, which gives a power of the order of 1,000 kw. for a small fraction of a second, was described.

Times switches for making and interrupting strong currents up to 12,000 amp. were described.

An account was given of a high-frequency oscillograph (20-30,000 per sec.) for measuring strong currents occurring during a small fraction of a second.

The construction and measurement of the magnetic constant of coils for producing magnetic fields was discussed.

An account of some experiments in obtaining strong fields was given.

N. AHMAD and E. C. STONER, *On the Absorption and Scattering of γ-Rays.*

The results of previously reported experiments on the absorption of γ-rays from Ra B + C, after filtration through 1 cm. lead, are further analysed, and the scattering is estimated from the apparent absorption with the absorbers close to and away from the ionisation chamber.

The scattering per electron is found to be approximately constant, which supports the view that the first term in the above expression corresponds to scattering absorption, the second to true absorption.

Estimates of the mean effective wave-length based on the two terms indicate that, for a given wave-length, Compton's mono-electronic quantum scattering formulæ give values, both for the total scattering absorption and for the actual scattering, which are lower than those observed.

V. HENRI, D.Sc., and H. DE LASZLO, *The Analysis of the Absorption Spectrum of Naphthalene Vapour: Structure and Activation of the Molecule of Naphthalene.* Communicated by Sir Ernest Rutherford, F.R.S.

The ultra-violet absorption spectra of vapours may be divided into three groups corresponding to triple, double or simple quantification of the electronic, atomic and molecular motion.

There is a change in the absorption spectrum of a vapour on approaching the higher frequencies. For low frequencies we obtain narrow bands with a fine structure. After a first limit the bands become continuous without fine structure; after a second we get broad continuous bands. The first limit indicates an intra-molecular change in distribution of electrons; the second corresponds to ionisation of the molecule.

For naphthalene, the first limit of "Intramolecular Ionisation" corresponds to an increase of energy of 101,000 cal.gr./mol., the second, "Ionisation of the molecule," to 230,000 cal. gr./mol.

The absorption spectrum of naphthalene vapour consists of two groups of bands: A, 2,820—2,500 A, narrow continuous bands; B, 3,200—2,820 A, narrow bands with fine structure. There are more than 400 fine bands in this group.

The distribution of the bands of group B can be represented by a single formula with three fundamental atomic frequencies.

$\alpha = 474.4$, $\beta = 203.4$, $\gamma = 62.7$ cm.$^{-1}$.

The main frequency is about half that of benzene and its mono derivatives. It is supposed that this frequency corresponds to the vibrations of the two benzene nuclei in the molecule of naphthalene.

The fine structure of the band is represented by the sum of three series, corresponding to a positive, negative and zero branch.

The moment of inertia of the naphthalene molecule changes activation. The distribution of the atoms in the activated and in the normal molecule is therefore different.

W. JEVONS, *On the Band-Spectra of Silicon Oxide and Chloride, and Chlorides of Carbon, Boron, and Aluminium.* Communicated by Prof. H. C. Plummer, F.R.S.

The uncondensed discharge through $SiCl_4$ vapour develops a characteristic system of ultra-violet bands degraded towards the further ultra-violet, and consisting of two parts, one on each side of a dense cluster composed of chlorine lines and aluminium chloride bands near λ 2610. Each part is further divisible into several "sub-systems" of groups of equidistant bands. The new system is attributed to a chloride of silicon.

When air or oxygen is present with $SiCl_4$ vapour in the discharge tube a second system of ultra-violet bands is developed, with heads degraded towards the red. Evidence is adduced for ascribing this system to an oxide of silicon. New measures of the observed bandheads have been correlated. The oxide bands are developed also in the arc in air.

The $AlCl_3$ uncondensed discharge also develops characteristic bands in the ultra-violet, the more prominent occurring together with Cl lines, in a dense cluster near λ 2610. They are degraded towards the red, forming several groups, each exhibiting an arithmetical progression of first differences of successive wave-numbers. The same cluster of bands and Cl lines occurs in $SiCl_4$ and BCl_3 discharge-tubes with aluminium electrodes, but the Cl lines relatively stronger and the bands relatively weaker compared with the $AlCl_3$ discharge.

Bands developed in CCl_4 and BCl_3 discharges are briefly described and measures given for the heads of the more prominent bands attributable to chloride in each case. The presenee of oxygen with the chloride vapour in the discharge tube has the same effect with CCl_4 and BCl_3 as with $SiCl_4$, namely, the development of an oxide band-spectrum.

Band-systems, attributed originally to boron nitride, but recently to boron monoxide are not developed with oxide bands in the tube discharge through BCl_3 and oxygen mixture. The later view as to the origin of band-systems of boron nitride does not accord with this observation.

Papers read in title only:—

J. E. LITTLEWOOD, F.R.S., and A. WALFISZ, *The Lattice-Points of a Circle.*

R. C. JOHNSON, *Ultra-Violet Emission Bands Associated with Oxygen.* Communicated by Prof. T. R. Merton, F.R.S.

Of spectra attributed to oxygen the best known are the negative band-spectrum and a system in the far ultra-violet at λλ 1830—1930. A well-defined system of bands,

legraded to the red and stretching from λ 2280 to 5000, was found in pure oxygen tubes by Stark in 1914. This was attributed by him to ozone on the basis of a comparison with the known absorption bands of ozone.*

The writer finds that this identity cannot be sustained, however, and attributes the band system to an oxygen molecule. The bands have been found to fall into 9 series well expressed by the formula:

$$\nu = \begin{matrix} 1620 \\ 1420 \end{matrix} + 16.945\, p^2 - 13.37\, m^2,$$

where m takes values from 25 to 34, and p from 55 to 47.

H. S. ALLEN, D.Sc., *The Band-Spectrum of Hydrogen.* Communicated by Prof. O. W. Richardson, F.R.S.

THE ROYAL INSTITUTION.

A General Meeting of the members of the Royal Institution was held on June 2, Dr. J. Mitchell Bruce, Manager and Vice-President, in the chair. Mr. S. Corner, Mr. F. Gill, and Mr. G. W. Thompson, F.R.C.S., were elected members.

THE CHEMICAL SOCIETY.

JUNE 5.

Papers read:—

Studies in Dynamic Isomerism. Part XVI. Mutarotation of Beryllium Benzoylcamphor. Formation of an additive Compound with Chloroform. The Optical Activity of Beryllium, by H. BURGESS and T. M. LOWRY.

Beryllium benzoylcamphor, $Be(C_{17}H_{19}O_2)_2$ is a colourless crystalline compound, m.p. 208°. It shows a slow mutarotation from 490° to 443° in benzene. The material can be recovered, and after slow crystallisation exhibits the same high initial rotation and subsequent mutarotation as before. The mutarotation can be catalysed by piperidine. Benzoic acid also produces a permanent decomposition. Measurements of solubility have given the proportion of the initial form in the final equilibrium-mixture in alcohol and in acetone, whilst from concurrent measurements of the optical rotatory power of the saturated solutions the specific rotation of the unknown labile isomeride in these two solvents has been deduced.

Beryllium benzoylcamphor unites with two molecular proportions of chloroform to produce the additive compound $Be(C_{17}H_{19}O_2)_2.2CHCl_3$. This crystallises in prisms instead of in discs; but these gradually become opaque by loss of chloroform. When dissolved in benzene or acetone, the additive compound gives at once the *final* rotatory power of beryllium benzoylcamphor in these solvents; but when dissolved in chloroform the last stages of a rapid mutarotation were observed. The free beryllium compound also exhibits a very rapid mutarotation in chloroform, which appears therefore to have a definite catalytic action on the mutarotation.

The cause of the mutarotation is not certain, but it is attributed provisionally to the opening out and closing again of the ring-system of a co-ordinated complex of the cyclic type.

Studies of Valency. Part IV. Absorption Spectra of Camphor, Benzylidenecamphor and Camphorquinone, by T. M. LOWRY and MISS H. S. FRENCH.

A solution of camphor in alcohol shows band at log ϵ=1.57, λ=2880. In benzylidenecamphor the band is moved to log ϵ=4.32, but the wave-length is practically constant at 2900. In camphorquinone the wave-length is altered to 4650, but the intensity remains practically constant at log ϵ=1.46.

THE OPTICAL SOCIETY.

JUNE 12.

Papers read and discussed:—

Wide Angle Ortho-Stereoscopy: Its Optical, Practical and Psychological Advantages, by COL. L. E. W. VAN ALBADA (of Amsterdam).

Binocular Vision and the Stereoscopic Sense, by R. J. TRUMP, B.Sc.

Both papers were illustrated by demonstrations and exhibits.

The following paper was read in abstract:

A General Solution of the First Order Aberrational Conditions, by T. SMITH, M.A., F.Inst.P.

Some of the more important items form monographs in themselves. That care has been taken to bring the information up to date is noticed on glancing at the references to recent work so freely given.

For a period of 13 weeks the South African Newspapers' Bureau, *British Empire* Exhibition, will publish "The South African," which will be sent to any address on receipt of the postage only. The weekly is issued gratis, and contains industrial and general news of South Africa.

BOOK RECEIVED.

Standard Methods of Testing Petroleum and Its Products. Pp. X. + 100. London: The Institution of Petroleum Technologists, Aldine House, Bedford Street, Strand. 1924. 6s. net.

New Patents.

This list is specially compiled for *The Chemical News* by Messrs. Rayner & Co., Registered Patent Agents, of 5, Chancery Lane, London, from whom all information relating to Patents, Trade Marks, and Designs can be obtained gratuitously.

Latest Patent Applications.

11655—Brunner, Mond & Co., Ltd.—Process of making ammonia by catalysis. May 12.

11751—Fulweiler, W. H. Quantitative determination of hydrogen sulphide in gas. May 12.

11676—Metal Traders' Technical, Ltd.—Process of concentrating sulphuric acid. May 12.

11846—Schmidt, E.—Obtaining hydrochloric acid free from arsenic. May 13.

Specifications Published this Week.

209379—Koppers Co.—Treatment of ammonia-charged gas.

210982—Koppers Co.—Process and apparatus for the removal of hydrogen sulphide and other noxious constituents from gases containing them.

206469—Bakelite Ges, and Hessen, Dr. R.—Manufacture of condensation products from phenols and formaldehyde.

Abstract Published this Week.

213088—Electrolysis.—Cruse, H., of 48, Stockport Road, Hyde, Cheshire.

Aluminium acetate is obtained by anodic solution of aluminium in an electrolyte of acetic acid, which may be crude or pure accordingly to acid, which may be crude or pure according to the purity of salt desired. The reaction is carried on until the whole of the acid is neutralised, which is signalised by a diminution in the current. The cell may be of wood or of aluminium; in the latter case it forms the cathode. The cell may be water-jacketed for the purpose of heating or cooling.

Messrs. Rayner & Co. will obtain printed copies of the published specifications and abstract only, and forward on post free for the price of 1s. 6d each.

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THE CHEMICAL NEWS,

VOL. CXXVIII. No. 3349.

SPIRO COMPOUNDS WITH REFERENCE TO FORMATION AND STABILITY.

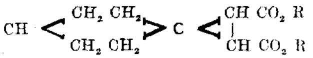
Part I.—Spiro Compounds of Cyclohexane.

By R. F. Hunter, M.S.Chim., F.C.S.

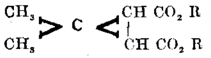
The researches of Thorpe and Ingold and their collaborators were undertaken with *the view to ascertaining the effect produced* by the alteration in the tetrahedral angle consequent on ring formation, on the formation and stability of a second ring linked to the existing ring by a spirane carbon atom common to both.

In accordance with the Strain Theory of Baeyer (*Ber.*, 1885, XVIII., 2277), the *normal* angle *of the tetrahedron will of* necessity be altered in the production of the cyclohexane ring, and the amount of change necessary to produce ring formation will depend in general on the character of the ring which is to be formed in the process. It, then, is possible that the angle formed by the two side chains attached to any *one carbon atom* of, say, a *cyclohexane* ring, will be altered in proportion to any change of angle between those valencies which participate in ring formation, or to put it another way, the groups attached to two side chains emanating from the same carbon atom of a cyclohexane derivative are closer together than in the corresponding *open chain compound.*

Clearly at this point we have a choice of two hypotheses, firstly one in which we can assume that the bending outward of the two valencies participating in the ring causes the other two to distribute themselves equally in the remaining space, or secondly, we have that if the two remaining valencies of the carbon participating in ring structure retain the tetrahedral angle, then the space will be distributed equally between the other two valencies; that is to say, that the forcing apart of the valencies to form the cyclohexane ring does not cause the other two valencies to converge. The proof of either hypothesis clearly would be revealed by a comparison of the conditions of spiro ring formation from the cyclic structures with the corresponding open chain derivatives. If the conditions were as postulated in the second case, that is, the divergence of the first two valencies does not cause the convergence of the remaining two, then there would be no difference between the two types of structures, that is, between the cyclic compounds and spiro compounds. If, on the other hand, the first suggestion were correct, then there would be a *greater tendency to form ring* compounds from cyclic structures owing to the closer proximity of the groups attached to the side chains of the carbon atoms through the agency of which ring formation has to take place. To give an example: if the first hypothesis were correct, then there would be a greater tendency to form the *spiro compound* (1) than *the ring compound* (2), whereas if the second suggestion were correct, the tendency would be the same in both cases. In 1915, Thorpe, Beesley and Ingold drew a comparison between *the conditions controlling ring formation* from derivatives of *ββ* dimethylglutaric acid and cyclohexane 1 : 1 diacetate, and their experiments clearly verified the first hypothesis.



(1)



(2)

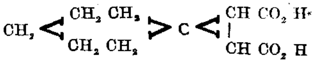
In 1899, Thorpe and Perkin studied the conditions of ring formation by the elimination of *hydrobromic acid from dimethyl*glutaric acid brominated on either one or both of the alpha carbon atoms. The conclusions they reached were that the monobrominated derivative gave a mixture of the cyclopropane compound and the corresponding lactone when treated with alcoholic potash, but that sodium carbonate gave only the *lactone*. With regard to the dibromo derivative: during an attempt to isolate the corresponding unsaturated ring compound, this was investigated, and it was found that the action of alcoholic potash produced a mixture of the hydroxy lactone and ethylcarbonic acid formed by the

addition of alcohol at the unsaturated linkage. In 1911 a method was devised for the preparation of large quantities of cyclohexane 1 : 1 diacetatic acid, and hence this was first used by Ingold, Beesley and Thorpe for the comparison in the manner indicated in 1915.

There is a marked difference in the behaviour of the cyclic compound and open chain compound on bromination by the Hell Volhard Zelinsky method of bromination. In the case of the dimethylglutaric acid derivative, it is possible to obtain a monobromo ester by using the theoretical bromine for the reaction, but with the cyclohexane derivative under these circumstances the chief products were the dibromo compound mixed with unbrominated ester. If only enough bromine was used to form the dibrominated ester, then an acid product was isolated, which was the acid ester of the monobrominated derivative.

A comparison of the behaviour of ethyl $\alpha\alpha'$ dibromo $\beta\beta$ dimethylglutarate and ethyl $\alpha\alpha'$ dibromo cyclohexane 1 : 1 diacetate supplied the first experimental evidence in favour of the view that there is a greater tendency to ring formation in the latter than in the former. Ethyl dibromoglutarate is a stable substance, which can be distilled without decomposition at 194/30 mm. It is also a homogeneous compound. On the other hand, however, ethyl dibromocyclohexane 1 : 1 diacetate is always obtained in a mixture of the cis and trans forms. The trans form is for the better part converted into the bromo lactone ester under the experimental conditions used. A certain amount, however, remains unchanged, and accompanies the stable cis dibromo dicarboxylic ester. They can be separated by means of boiling pyridine, which removes the ethyl bromide from the trans modification and leaves the cis unattacked. The cis dibromo ester is completely converted into a mixture of bromo lactones on distillation, from which the above trans brom lactone ester can be prepared. The second substance is the cis bromo lactone ester, formed from the cis brom ester without a change of configuration. It is worthy of note that these substances, which are, strictly speaking, derivatives of glutaric acid, since the end groups are separated by three carbon atoms, are actually more nearly related to compounds of the succinic type. The action of alkali on the two forms of bromo lactone further supplies evidence of the structure (*J.C.S.*, 1915, CVII., 1085).

The above, then, clearly affords direct experimental evidence of the first hypothesis, namely, that if we augment the angle between the two valencies of a tetrahedral carbon atom by means of cyclohexane ring formation, we cause the remaining two valencies to converge such that ring formation becomes easier to bring about than in the corresponding open chain derivatives. From the hypothesis discussed, the stability of ring structures derived from cyclohexane will be greater than those obtained from open chain derivatives. A comparison of the spiro acid and caronic acid showed this to be correct.



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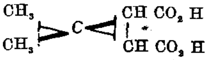
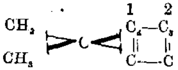
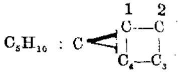


(4)

Both the acids are stable to boiling permanganate, but when the two acids were heated with concentrated hydrochloric acid in a sealed tube at 240°, there was a considerable difference in the results, for under such conditions the spiro acid was practically unaffected and caronic acid was completely converted into tere bic acid, and this furnishes direct evidence of the greater stability of the ring compound over the open chain derivative.

In 1919, Profs. Thorpe and Ingold studied the bridged spiro compounds of cyclohexane, and studied substances of a more complex type, namely, those which contain a cyclopropane ring joined to a cyclobutane ring by two carbon atoms common to both, the structures of which are indicated in outline by (5) and (6).

(5) 

 (6)

Consider the carbon atoms of cyclopropane as being points at the corners of an equilateral triangle. In aliphatic compounds such as ethane there is little doubt that the resultant of the attractive forces *binding the carbon atoms is a straight line* from the centre of one carbon atom to the centre of the other, that is that the valency is a straight line. When, however, we consider cyclopropane the matter is more complex. Here, according to the Strain Theory, each of the carbon atoms of the ring is reacting on those of its valencies, which take part in the ring in such a way as to tend to make them emanate from atoms at directions inclined to one another at $2 \tan^{-1} \sqrt{2}$. Now, if the carbon atoms were entirely successful in bringing about this result, then, since two of the valencies emanating from the same carbon atom at an *angle of* $2 \tan^{-1}\sqrt{2}$ *have to reach the* two remaining corners of the equilateral triangle, *it is clear that the only way which they can* do so is by describing curves. The simplest curve would, of course, be the arc of a circle, each of the terminal tangents of which makes an angle of $\tan^{-1}\sqrt{2}$ with the median through the corresponding corner of the equilateral triangle. This represents a state in which the carbon atoms would be wholly free from distortion of the type we are considering, the whole being borne by the valencies, that is to say, the physical stress would reside wholly in the interatomic medium in which the forces of valency are propagated. The valencies will, however, tend to reduce their potential energy by shortening this path, and if they were completely successful would result in stretching themselves as straight lines, joining the carbon atoms to one another. This, however, would throw the whole of the strain back on the carbon atoms, since now the initial directions in which the ring valencies leave the carbon atom are inclined, not at $2 \tan^{-1}\sqrt{2}$, but at $\pi/3$. It is probable, then, that an equilibrium is set up, and that the valencies occupy paths which lie between the straight lines and the limiting arcs, *such that part of the strain is* taken up by the carbon atoms and part by the bent valencies.

The strains which exist in one ring of a spiro compound clearly could not make themselves felt in the second ring, other*wise than via the spirane carbon atom* Now the work of 1915 showed that such a communication of strain does actually take place across the ring, and this demonstrates clearly that the spirane carbon atom itself is in a condition of strain.

Thus, when part at least of the strain of the cyclohexane ring is actually taken up by the carbon atoms, then from a graphical point of view, we can say that the valencies *of the cyclohexane ring, and incidentally of* any other alicyclic ring, occupy paths which are somewhat flatter than the limiting arcs, the terminal tangents of which meet at the normal angle of $2 \tan^{-1}\sqrt{2}$. It was shown, however, by the 1919 research, that it is more difficult to close the cyclobutane ring to form bridged spiro compounds than it is to form bridge structures of the type (5). Further, the former are less stable than the latter in certain specific positions. If the stresses existing in the cyclohexane ring can be communicated to the cyclobutane ring, *or to the side chains* attached to the cyclopropane ring before the cyclobutane ring is closed, then it is clear that the valencies of the cyclopropane ring take part in the transmission of stress *as well as the spirane carbon atom.* With valencies which are quite unstrained it is quite inconceivable that this could happen, and hence one must presume that the valencies themselves are in a condition of strain. The graphical aspect of this is that the valencies concerned must lie in paths which are distinctly curved. The curvature of the path will be less than the limiting arcs, the terminal tangents of which make an angle of $2 \tan^{-1}\sqrt{2}$, and the path may *therefore* be taken to be one which lies between the limiting arc and the straight line. Where exactly the position of equilibrium of a particular valency lies, and what precisely is its precise shape, it is at present impossible to predict, but the view expressed above accounts in a satisfactory

manner for the results of experiments carried out at South Kensington. Accepting the view that the more a valency is strained the more it will tend to break, then among the factors determining the equilibrium we have the number of groups attached to the carbon atom concerned, *for the tendency which ring compounds exhibit* to undergo fission between quaternary carbon atoms is well known. The electrochemical nature of the substituents is, of course, another important factor. Clearly, then, we have three factors which affect the stability of a valency which participates in a fully reduced alicyclic ring. Firstly, we have the number of carbon atoms in the ring; secondly, the character and mode of *attachment of any. attached rings; and*, lastly, the number, distribution and character of the substituent groups.

As regards the first of these, Baeyer's simple conception has had a great degree of success, but it is only an approximation to the truth; and in its elemental form it does not take into consideration whether the atoms or valencies are the seat of postulated strain, and therefore ignores the second and third causes above. As far as we can see, the first and second causes determine the maximal strain or curvature which any valency may have to bear, and the third cause only operates in the sense that it settles which fraction of that maximum it shall bear. The trouble is to decide which mode of operation the third cause will bring about in the experiments, owing to its uncertain nature. The structure (5) is of particular interest; consider it for a moment: the fact that two of the valencies of the carbon atom (1) are held in the cyclobutane ring will cause the initial directions in which the other two valencies leave the carbon atom to spread out in such a way as to form angles with one another, and with the cyclobutane bound valencies, greater than would be the case if the butane ring was not closed. This involves an increase in the initial divergence of the valencies (1:4) and 1:5), the limiting arc being such that the terminal tangents are inclined to the medians at angles which are greater than $\tan^{-1}\sqrt{2}$ by, say, ϕ. The curvature is therefore greater than $\sqrt{2}-\frac{1}{3}\sqrt{3}$ by about $\frac{1}{6}(7-2\sqrt{6})\phi$.

The problem, however, was to see how the bridge ring compound (5) compared with a bridged spiro compound (6). It will be noticed that in the latter case the limiting curve of the valency (5:1) cannot be symmetrical, for while the carbon atom (5) is, on account of the cyclohexane ring, tending to reduce the angle which the terminal *direction of the curve makes with the* median to the value of $\tan^{-1}\sqrt{2}-\psi$, the carbon atom (1), as a result of being involved in the cyclobutane ring, is attempting to enhance the corresponding angle at that end of the curve to $\tan^{-1}\sqrt{2}+\phi$; the real curve, therefore, lies between the curvatures

$$\sqrt{2}-\tfrac{1}{3}\sqrt{3}-\psi/6\,(7-2\sqrt{6}) \quad \text{and} \quad \sqrt{2}-\tfrac{1}{3}\sqrt{3}+\phi/6\,(7-2\sqrt{6}).$$

Such a path, clearly, will be by far the greatest which the cyclohexane ring could be expected to have on the attached dicyclic system. The reactions of the bonds (1:2) and (1:4) are next in importance, but of the second order. It is of interest, however, to examine them briefly. The fact that the *limiting curve of the valency (5:1)* is depressed below the arc which corresponds to the limiting curve of the same valency necessitates that the true path of the same valency is even nearer the carbon atom (1). This involves a small effect on the valency (1:2) in the direction of an increase in the curvature of its limiting curve. The bond, (1:2) should therefore be a little more strained in the series (6) than (5). The effects of the strains in the cyclohexane *ring on the bridge bond (1:4)* are also of second order, the bond (1:5 being the determining factor.

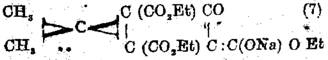
There remains the bond (2:3); the effect in this case is of the third order, and no doubt beyond experimental detection.

The most striking effect emerging in the experiments of Profs. Thorpe and Ingold was the marked decrease in the stability of *the bond (5:1)* when compared with the compounds of the series (5). The fission of this bond was brought about with great ease in certain substances of the type (6) by alkaline reagents which appeared without effect on the type (5). This, of course, was in agreement with the conclusions regarding flexible valencies. Definite evidence was also obtained of the bond (1:2) on the spiro compounds. The expected effect is in the nature of an increase in strain, that is, a decrease in stability, but

is rather small, and the reagent was not actually found which was capable of breaking the bond in (6) without doing so in (5). Fortunately, though, there was a delicate means of experiment. The cyclohexanespirodicyclopentane structure (6) was obtained from cyclohexane 1:1 diacetic acid by a method involving first the closing of the cyclopropane ring and then the cyclobutane ring by the establishment of the bond (3:4). Now, the additional instability which we may be led to expect of the bond, (1:2), to exhibit in the *spiro* structure, is due to the tendency, which there is owing to the cyclohexane ring for the angle between the bonds (1:4) and (1:5) to increase. It is clear that this tendency will not be resisted by the strained bonds of the cyclobutane ring, the result being to magnify the effect of drawing apart of the carbon atoms (3) and (4) to an extent which can be sufficiently great to make a difference in the difficulty in establishing the cyclobutane ring in the series (6) than in (5).

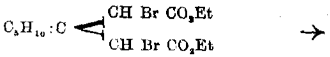
The experiments showed that the strain in the cyclohexane ring had to be communicated to the bond (1:2), which means the bond (5:1), as well as the carbon atoms (5) and (1) is in a state of strain.

Concerning the bonds (1:4) in (5) and (6), a good method was available, since sodium amalgam breaks the bond without attacking any of the other bonds in the molecule. By making comparative experiments, it was found that there was a considerable difference in the reaction velocities, the reaction being much easier in (6) than (5). Thus, the experiments of Profs. Thorpe and Ingold were clearly in agreement with the theoretical considerations. When the dibromo ester of $\beta\beta$ dimethylglutaric acid was condensed with ethyl malonate and sodium ethoxide, the ultimate product was an insoluble yellow sodium derivative of ethyl dimethyldicyclopentanonetricarboxylate (7).

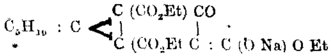


(7)

It was therefore expected that if cyclohexane 1:1 diacetic acid was used, instead of the glutaric acid derivative, that the reaction would be:



(8)



(9)

The sodium derivatives (7) and (9) belong to the types (5) and (6), and it was therefore decided to make their formations and decompositions subjects for comparison. It was found possible to prepare the sodium spiro compound (9) direct from ethyl dibromocyclohexane diacetate and ethyl sodiomalonate under the same conditions as are employed for the production of the ring compound (7) from ethyl dibromodimethylglutarate. Direct comparison of the two condensations was complicated owing to the fact that whilst ethyl dibromodimethylglutarate can readily be prepared in a condition of purity by distillation, the corresponding cyclohexane derivative decomposes when distilled, and a product of 80 per cent. purity has to be used. Nevertheless, the results were definite, for while a 60 per cent. yield of the former was obtained, only a 13 per cent. yield of the spiro compound was obtained. To make the matter more definite, the velocities of formation were studied, and it was found that the bridge ring compound is formed with a much greater velocity than the bridge spiro compound. The hydrolytic decompositions of the derivatives (7) and (9) were studied, and it was shown that the bond 4:5 in the spiro compounds is in a condition of great strain. The hydrolytic decompositions of the methylation products of the bridge ring derivatives (7) and (9) were studied, and further confirmed the fact that the bond 4:5 in the spiro series is remarkably unstable. The reduction of the monocarboxylated bridge ring derivatives were then studied. The second order effects referred to in this paper of the bonds 1:2 and 1:4 were detected.

Highbury New Park,
N.5.
May, 1924.

British Empire Exhibition.

NOTES ON EXHIBITS IN THE CHEMICAL HALL.

(*Continued from Page* 383.)

MRS. I. S. MACLEAN AND MISS D. HOFFERT, of the Lister Institute, London,

Are showing sterol from yeast fat, which is identical with ergosterol.

Also specimens of fat obtained from dried pressed yeast by direct extraction with ether, which contains the vitamin necessary for growth.

Also specimens of fat obtained from dried pressed yeast by hydrolysis and extraction with ether, which does not contain the growth factor.

PROF. P. T. P. BARKER, M.A., of the University of Bristol.

The exhibits comprise a series of compounds representing some constituents of the apple and their derivatives. Also:—

1.—Glass cylinders of apple juice in different stages of fermentation, illustrating the normal course of fermentation of apple juice.

2.—Glass cylinders of cider, showing the difference in degree of attenuation of juices containing initial, low, medium and high content of nitrogen respectively.

3.—Glass cylinders containing specimens of cider affected with the disorders of acetification, ropiness and blackening.

4.—Glass cylinders of ciders illustrating the disorder of cider sickness, and the difference in susceptibility to this disorder between ciders of high and low acid content.

In addition, cultures of conjugating yeast and a typical cider yeast, also Freudenreich flasks containing living cultures of the cider sickness bacillus, various types of acetic bacteria found in cider and the ropiness bacillus.

Charts showing: (a) The influence of temperature on the rate of fermentation, (b) a typical fermentation curve for slow fermenting type of cider, (c) ditto for a medium, (d) ditto for a high, (e) fermentation curve for a cider attacked by a sickness disorder.

DR. A. C. THAYSEN, of the Royal Naval Cordite Factory, Holton Heath, Dorset.

A diagramatic sketch of a factory for butyl alcohol-acetone production. Two photographs of an actual factory. Five sketches showing the responsible micro-organism and the most important types of infection. Tubes containing the butyl alcohol-acetone bacillus: others containing mash before and after fermentation; mixtures of butyl alcohol-acetone, pure butyl alcohol, pure acetone and eight specimens of butyl derivatives, besides a sample of feeding cake prepared from the solids of the fermented mash.

In addition, there is a list giving the yields obtained from a number of different raw materials.

PROF. R. H. A. PLIMMER, of St. Thomas's Hospital, London.

The Constituents of Eggs.

The eggs of birds are composed of shell, white and yolk.

The shell consists of a membrane (a scleroprotein), covered with calcium carbonate. During development of the chick, calcium passes from the shell to the embryo through the membrane. The membrane has not normally calcium carbonate in it, but this is found during incubation. The pigment of the shell is allied to the blood pigment and consists of ovoporphyrin, possibly identical with hæmatoporphyrin.

The white is composed chiefly of proteins with traces of salts, fats and glucose. Three proteins are distinguished: (1) Ovalbumin, which can be crystallised; (2) Conalbumin, which cannot be crystallised (both these are coagulated by heating); (3) Ovomucoid, a glycoprotein, not coagulated by heat.

The yolk is usually yellow. This yellow pigment is called lutein, and is allied to the xanthophyll present in green leaves and yellow seeds, such as maize. It is derived entirely from this kind of food. Hens fed on white food, such as rice, lay eggs with white yolks. The substance of the yolk contains two proteins: (1) Vitalein, insoluble in water and containing 1 per cent. of phosphorus, and belongs to the group of phosphoproteins. Phosphorus is easily removed as phosphoric acid by the action of dilute caustic soda. (2) Livetin, soluble in water, and coagulated by heat. It contains 0.1 per cent. of phosphorus. The yolk also contains: (3) Lecithin, composed of glycerophosphoric acid, choline and fatty acids; (4) Fats; (5) Cholesterol.

Specimens for exhibit:—

A.—Shell: (1) Membrane protein (scleroprotein); (2) solution of porphyrin—allied to hæmatoporphyrin.

B.—White: (1) Total coagulated protein; (2) crystalline ovalbumin; (3) ovomucoid.

C.—Yolk: (1) Dried white yolk and dried yellow yolk (these will go brown in time); (2) vitellin; (3) livetin; (4) lecithin cadmium chloride (will go brown in time); (5) lecithin; (6) sodium glycerophosphate; (7) choline mercuric chloride; (8) cholesterol.

Also egg with white and egg with yellow yolk, mounted in same jar; and possibly also chick (white) from white yolk egg, and chick (yellow) from yellow yolk egg.

PROF. A. W. CROSSLEY, C.M.G., F.R.S., of the British Cotton Industry Research Association, Shirley Institute, Didsbury, Manchester.

The Constituents of the Waxes of American and Egyptian Cottons.

The term "wax" is loosely used in the case of cotton to cover the substance extracted by means of such organic solvents as carbon tetrachloride or benzene.

The substances extracted from the cotton include fatty acids and the corresponding glycerides, wax esters, acids and alcohols, phytosterols and the corresponding glucosides, and usually a small proportion of resinous matter as well. The heterogenous character of this material will be seen from the number of substances isolated and identified, most of them independently from two American cottons and one Egyptian cotton. Some of them have not been previously described, the principal being *montanyl alcohol* ($C_{28}H_{57}OH$), *gossypyl alcohol* ($C_{30}H_{61}OH$), an *alcohol* ($C_{32}H_{65}OH$), and *alcohol* ($C_{34}H_{69}OH$), and the corresponding *acids*, and also a phytosterol ($C_{29}H_{49}OH$) and the corresponding glucoside.

Technically, the waxy material is considered of importance in spinning, as it probably lubricates the individual hairs during the process, whilst its removal is one of the objects of scouring and bleaching, as it interferes with the success of certain finishes.

DR. R. H. PICKARD, F.R.S., Battersea Polytechnic, London.

Exhibit of Leather Research Association.

It has long been realised that the properties and value of leather are very largely governed, not only by the type of skin employed and its previous history, but also by the processes which it undergoes previous to the actual tanning. The study of the effect of these processes upon the raw material is the only logical foundation to any complete understanding of the factors which determine the properties of the resulting leather.

The microscope has been applied to this particular branch of research with a very considerable amount of success, and a few of the results that have been obtained by its application are illustrated by means of the photomicrographs exhibited.

These show that the part of the skin or hide which the tanner makes into leather is mainly composed of fibre bundles of a protein (collagen) interlaced with a network of fibres of a different protein (elastin).

They demonstrate the effect of the various agents usually employed by the tanner in his preparatory processes of soaking, unhairing, bating, etc., and also some new facts of considerable practical and scientific importance. Notably one of the fundamental differences between fresh and dried hides, the selective action of a drastic unhairing agent, the effect of various agents both chemical and biological in the separation of the fibre bundles into their component fibrils, a condition that leads to the production of a supple leather, and finally the mechanism of the degradation of the elastin of an animal skin is demonstrated for the first time.

The application to practice of the knowledge of the structure of hides and skins, gained from such observations, has rendered possible the elucidation and rectification of many of the faults in finished leather which are attributable to irregularities in the preliminary processes.

MR. J. W. WOOD, of Messrs. Turney Bros., Ltd., Nottingham,

Is also showing specimens illustrating his researches from 1892 to 1898 on the constitution and mode of action of the Dungbait in leather manufacture. Enzymes from dog dung prepared in 1892. Purified enzymes from dog dung. Trypsin extracted with hydrochloric acid. Trypsin precipitated with alcohol. Pancreastic enzymes as prepared in the manufacture of pancreol. Pancreol enzymes preparations re-

sulting from researches made 1892-1898.

MR. J. A. GARDNER

Exhibits a new form of extractor, in which there are no joints, and by varying the height of the holder or the condenser—or both—above the level of the liquid in the bulb, the extractions can be done at any temperature up to the boiling point of the solvent.

Diagrams illustrating the apparatus used by this investigator in determining the respiratory exchange in fresh water fish.

PROF. S. B. SCHRYVER, of the Imperial College of Science and Technology, South Kensington, London.

1.—Plastic materials made from the residue of castor beans after expression of the oils.

By the action of alkalis on the proteins contained in the beans an adhesive material is formed, which binds together the cellulose and other substances, which thus act as filling.

2.—Gelatines from various sources. These include a gelatine which has been purified by flocculation in an electric field. This is in an unionised condition and freed from its degradation products which are always present in commercial gelatines.

3.—A triose, hitherto undescribed, obtained from cabbage leaves, in a yield of 10 grams from 90 kilos. It has the formula CH_2 (OH) CH(OH) —C— CH_2 (OH).

4.—Hemicelluloses. These include the hemicelluloses from oak, beach, and their degradation products, which are chiefly pentoses. Also the hemicelluloses from flour, which is also found in most commercial starches in small quantity, and which yields, on hydrolysis, glucose and no other simple sugar. It dissolves in hot water and separates from the hot solution on cooling as a flocculent powder. It yields no gel with hot water, and gives the blue colouration with iodine.

5.—The hydrolysis products of casein and gelatin. These have been separated by a new method worked out in the laboratory by means of which the acids can be separated into groups containing only a few acids, without having recourse to the method of esterification.

DR. R. A. O'BRIEN, of the Wellcome Physiological Research Laboratories.

The exhibits are selected to illustrate some recent research in the field of bacteriology, immunology and physiology.

Dysentery Serum (Shiga).

The League of Nations Committee on Standardisation of Sera is investigating the various international standards and methods of testing. Agreement has already been reached concerning diphtheria and tetanus antitoxins. The stable toxin and antitoxin exhibited have been prepared for the Committee in connection with the attempt to establish an international standard for the testing of dysentery antitoxin. The chart attached shows the degree of consistency attained in rabbit tests.

Veterinary Diseases.

Two sections of the research work in progress form the chief part of this exhibit: (1) the organisms associated with diarrhœa in chicks and fowls, including the dangerous bacillary white diarrhœa; (2) various anærobic organisms which may be associated with disease in animals.

DR. T. A. HENRY, Director of the Wellcome Chemical Research Laboratories.

Organic Compounds of Mercury.

Mercury has been used in medicine for over 400 years, and until Ehrlich's discovery of "salvarsan" in 1909, it was practically the only substance used in the treatment of syphilis. Clinical experience shows that the best results in the treatment of this disease are obtained by the combined use of "salvarsan" and some form of mercury. Although inorganic mercury compounds are powerful bactericidal agents, they are also very poisonous, they precipitate proteins and are decomposed by the metal of surgical instruments. Organic mercury compounds, *i.e.*, compounds which have mercury directly combined with carbon, on the contrary, do not in general possess these disadvantages; they do not precipitate proteins or react easily with metals, and are much less toxic than the inorganic salts.

The specimens shown were prepared during an investigation, which is still in progress, designed to determine the effect of the nature and position of substituents on the toxicity and germicidal action of organically combined mercury. For this purpose a comparatively simple substance, benzaldehyde, was selected, and derivatives of this systematically mercurated and their germicidal action investigated.

Organo-Metallic Compounds.

Arsenic.—One of the objections to the use of "salvarsan" in medicine is the complicated technique (necessitated by its excessive acidity) involved in its conversion into "sodium salvarsan" immediately before injection. Numerous attempts have been made to avoid this difficulty by the preparation of less acid analogues, which could be injected directly without risk. One of these attempts is illustrated by the arsenobenzenes derived from benzoglyoxaline (1:3-benzodiazole) shown here. The specimens exhibited also illustrate the results of a study of the composition of "salvarsan" and "silver salvarsan" and of the investigation of substituted phenylarsinic acids arising from a by-product in the process of arsenation.

Antimony.—So far but few organic derivatives of antimony have been prepared, and it became of interest to ascertain how these compared pharmacologically with the numerous substances, which can be obtained by substituting the potassium of "tartar emetic" by organic and other bases. The antimony derivatives shown are those prepared for this comparison.

Diphtheria.

The exhibits can be grouped as dealing with the following aspects:—

1.—*Diagnoses of Diphtheria*: Determination of virulence of the suspected organisms. Available evidence justifies the view that the avirulent Klebs Loeffler bacillus which does not harm guinea pigs, does not cause diphtheria and is a harmless organism. It can be distinguished from the true virulent K.L.B., the cause of diphtheria, only by animal tests, either by subcutaneous inoculation into guinea pigs, or by the more modern intradermic method. This permits from ten to twenty different cultures to be examined on one guinea pig (or more properly two), for there must be a companion animal previously injected with diphtheria antitoxin, and this animal must show no reactions.

Healthy people may carry in their throats the virulent diphtheria bacillus; these people are "carriers," and may spread diphtheria throughout the community.

2.—*Prevention of Diphtheria*: The exhibits deal with the Schick test and active immunisation, and the methods of testing the reagents used. By the use of this test it is easy to distinguish people who are naturally immune against diphtheria from those who are susceptible. The susceptible, when found, may be immunised by injecting prophylactic. This usually consists of a mixture of toxin and antitoxin which does not injure injected patients and yet rapidly causes them to develop immunity to the disease. Attempts are constantly being made to improve the prophylactic. The high water mark yet reached is illustrated by the concentrated "toxoid," with which it is possible to produce detectable immunity in a guinea pig or rabbit in from 11 to 16 days.

3.—In connection with this work are shown concentrated diphtheria toxin. Immunologists and biochemists, ever since Ehrlich's earliest research, have been endeavouring to analyse crude toxin, using for this purpose study of the different effects produced in animals and methods of concentration directed towards the eventual isolation of the true toxin.

Tuberculin.

Tuberculin is used for the treatment of human tuberculosis and also for testing for the presence of tuberculosis in cattle and in human beings. For this latter purpose it is important that tuberculin shall be standardised as accurately as possible. The most recent method, which has justified itself in practical use for several years past, is exhibited. Intradermic inoculations into tubercular guinea pigs enable one to judge with reasonable accuracy the value of a given tuberculin.

Tests for Syphilis.

The Sachs-Georgi flocculation test is exhibited and also dried specimens of the various reagents used in the test. The discovery that it is possible to keep these reagents in stable form enables the worker in the tropics to carry on his clinical tests with confidence; it also makes it possible for the research worker to carry on a long investigation with reagents that remain stable during the whole investigation.

Investigation of Anthelmintics.

The materials shown include:—

1.—Products isolated from various species of *Artemisia* suggested as possible sources of santonin.

2.—Constituents of chenopodium or

American wormseed oil and derivatives prepared from them.

3.—A series of substances prepared for trial in hookworm disease. These represent various classes or organic chemicals, and it was found that of the whole series only two groups, the phenols (*e.g.*, amyl- and butyl-phenols), and the aromatic alcohols (*e.g.*, phenylethyl alcohol) exhibited vermicidal properties *in vivo*, the former being markedly and the latter moderately active. None of the substances tried was more efficient than the drugs already used for hookworm disease, viz., thymol, chenopodium oil, and carbon tetrachloride.

Natural Drugs and Poisonous Plants.

Of the numerous investigations of natural drugs and poisonous plants conducted in these laboratories since 1896, a few typical examples have been selected for exhibition. Of these, special reference may be made to the following:

Chaulmoogra and Hydnocarpus Oils.—These oils, which have long been used in the Far East as remedies for leprosy, have been shown to consist of glycerides of optically active acids, having a homocyclic nucleus of five carbon atoms with a long side chain. There is some evidence that the value of the oils in leprosy is due to the action of these peculiar acids, and it is on this basis that esters of the latter have been introduced for the treatment of leprosy, and are being successfully used in India, the Pacific Islands and elsewhere.

Anti-Dysenteric Drugs.—It has long been known that ipecacuanha contains three alkaloids, emetine, cephaeline and psychotrine, of which emetine is the most important and is now largely used in the treatment of amœbic dysentery. Two new alkaloids, methylpyschotrine and emetamine, have been isolated from this well-known drug, and the interrelationships of the first four bases named above have been established (see special exhibit in Alkaloid Section).

This work has been extended to a number of other drugs used in the tropics as remedies for dysentery, including Kurchi bark and other species of Holarrhena, which all contain the active alkaloid conessine, and a group of drugs such as *Monsonia ovata* and *Rhyncosia adenodes* which, in spite of their local reputation, are probably of little real value, and owe such action as they exhibit to the slight amœbicidal action of the tannins they contain.

WILLIAM GOSSAGE & SONS, LTD.

The exhibit of William Gossage & Sons, Ltd., Widnes, situated at the corner of two main avenues in the Chemical Section, is one which is attracting considerable attention.

They are showing their principal brands of soap sold in home and foreign markets. Their exhibit also comprises silicates of soda and glycerine.

A special feature of the display is a model sea, on which are depicted scale replicas of famous British naval ships, over which hangs the slogan:—

Gossage's Soaps are like the British Navy—the best that ever entered water.

An attractive brochure, giving details of the war service of the battleships, is being given away, and makes an interesting souvenir of their exhibit.

BAIRD & TATLOCK (LONDON), LTD.

The Empire's lead in Science.
The work of Baird and Tatlock, Ltd.

Britishers have good reason to be proud of their tradition in science. To belong to the same race which produced a Newton or a Faraday fills us with a hopeful self-esteem which is pardonable. During the last hundred years, however, so extensively has specialisation caused science to branch out and in so many directions, that it is now impossible for a single mind to comprehend the present field of scientific knowledge. The more astounding is it, therefore, to find even a single firm which embraces science in its manifold divisions and applications. The firm of Baird & Tatlock (London), Ltd., is unique in this respect, and a study of their standard catalogues will reveal the extraordinary diversity of their activities. These catalogues, compiled as they are on a subject basis, now serve as text-books for students of science and handy works of reference for the routine worker in industrial laboratories, and the research worker in pure, biological, and applied science. We may quote here the review by a reputed physiologist of the second volume published in the journal Physiological Abstracts.

The first volume on chemical subjects,

the third on the biological sciences, and the *fourth on physics and related subjects*, are also written from the standpoint of the scientific man. Surely, we Britishers must also be proud of the fact that the only firm in the world which can manufacture such a range of instruments is a British firm situated in dear old London, the heart of the Empire. It is interesting to note the great adaptability of the workers of this firm, evidenced by the rapidity with which they undertook, in a time of national emergency, the manufacture of glass. This glass was pronounced by experienced glass-blowers as being the best ever yet made for the making of complicated scientific glassware.

An examination of the apparatus shown in the limited space of exhibit No. A.59, will immediately convince the onlooker of the praiseworthy realisation of this firm's success in keeping *abreast of research*. There need be no fear here of continental competition: instruments of precision do not lend themselves to mass production. In the few examples shown we see the inimitable skill of the British worker—the same skill that produced the English lever watch of a hundred years ago—watches which are still running. If any further evidence is required of the leading part played by this firm in the science of the world, a glance at the physiology exhibit in the Royal Society's section will at once reveal the fact that practically the whole exhibit consists of this firm's apparatus which may be seen actually working. This is all the more complimentary because British physiology holds a very leading position in the world's present contribution to this subject.

It is difficult for the lay visitor to realise the enormous diversity and importance of this firm's activities. Let us consider motoring, for example, since it is a means of transport which has grown in our own life-time. The increased use of the roads by motorists has necessitated a dust-free surface impervious to water under varying conditions of climate. For the testing of preparations (tar, bitumen, etc.), which will stand up to these requirements, we have the instruments of precision manufactured by this firm, which has led all over the world to the standardisation of these raw materials, and their combinations. No road surveyor would now risk [illegible] which has not been under test; previous to this, however, it was not an uncommon sight on some of the early bituminised roads to see the surface rolled up into folds. Similarly, to obtain the maximum efficiency and life out of the motor engine, lubricating oils and fuels must be distilled and suitably treated to yield an optimum viscosity and *flash point*; factors such as these can only be gauged by means of carefully constructed and standardised instruments. While speaking of motoring, and to further indicate the extraordinary range of this firm's work, it is interesting to recall their construction of complete mobile bacteriological laboratories for the combating of infectious diseases in our fighting forces in the late war; speed in the early diagnoses is the only way to nip infectious diseases in the bud.

To the pioneers who have struggled to *link up pure science to industry*, this firm holds out more than a gleam of hope, for side by side with apparatus for the pure science taught in schools and colleges, we have the equipment for work's laboratory, field work, hospital, etc. A survey of these catalogues will emphasise more and more the uniformity of nature and the entire absence of discontinuity between science and art.

The firm of Baird and Tatlock (London), Ltd., is to be congratulated on the great range of its highly technical productions, and on the skill of its workers, and on all the factors which contribute to the reputation "British manufacture" established the world over of first class quality and workmanship.

THE CONSTITUTION OF THIONIC ACIDS.

Errata.

The Chemical News, dated May 30.

Page 344, line 4 from bottom, col. 1: for "Tetrathionic Acid" read "Trithionic Acid."

Line 2 from bottom, col. 1: for "Pentathionic acid" read "Tetrathionic acid."

Line 1, col. 2: for "Trithionic acid" read "Pentathionic acid."

PROCEEDINGS AND NOTICES OF SOCIETIES.

THE ROYAL SOCIETY.

JUNE 19.

Papers read:—

LORD RAYLEIGH, F.R.S. *The Non-Luminous Oxidation of Phosphorus in an Oxygen Atmosphere.*

LORD RAYLEIGH, F.R.S. *The Light of the Night Sky: Its Intensity Variations when Analysed by Colour Filters.*

REV. A. L. CORTIE, D.Sc. *The 27-Day Period (Interval) in Terrestrial Magnetic Disturbance.* Communicated by Dr. C. Chree, F.R.S.

E. K. RIDEAL and C. G. L. WOLF. *The Destruction of Rennin by Agitation: A Case of Catalysis at an Air-Liquid Interface.* Communicated by Sir William Pope, F.R.S.

W. G. PALMER. *The Use of the Coherer to Investigate Adsorption Films.* Communicated by Sir William Pope, F.R.S.

W. G. PALMER and F. H. CONSTABLE. *The Catalytic Action of Copper. Part IV.* Communicated by Sir William Pope, F.R.S.

R. J. LANG. *On the Ultra-violet Spark Spectra of Some of the Elements.* Communicated by Prof. J. C. McLennan, F.R.S.

W. T. ASTBURY and KATHLEEN YARDLEY. *Tabulated Data for the Examination of the 230 Space-Groups by Homogeneous X-Rays.* Communicated by Sir William Bragg, F.R.S.

J. W. CAMPBELL. *On the Drift of Spinning Projectiles.* Communicated by Dr. J. S. Plaskett, F.R.S.

A. L. NARAYAN, D.Sc., and D. GUNNIAYA. *Absorption of Lithium Vapour.* Communicated by Lord Rayleigh, F.R.S.

THE FARADAY SOCIETY.

A General Discussion was held on June 11 by the Faraday Society and the Textile Institute, at the British Empire Exhibition, Wembley. The following papers were read and discussed.

Physical and Physico-Chemical Problems relating to Textile Fibres, by W. L. BALLS.

This was a short paper, in which it was shown that the defects of yarn and fabrics were formerly due to faults in the machinery employed.

Properties of the Silk Fibre, by W. S. DENHAM and T. LONSDALE.

The following properties were considered —Composition, Formation, Dimensions, Density, Structure, Double Refraction, Refractive Index, Lustre, Inhibition, Solubility, Action of Acid and Alkali, Elastic Properties, Specific Heat and Electrical Insulation. A number of other less important properties were also examined.

The Lustre Produced in Cotton by Mercerisation, by T. BARRATT.

Photographs of mercerised and unmercerised fibres are given, showing the difference in structural formation. The final conclusion was drawn that the light reflected from a mercerised fibre in certain positions was concentrated within a small angle.

The Physical Properties of Textile Fibres in Relation to Technical Processes and to General Colloid Theory, by S. A. SHORTER.

The following points were considered:—

(a) The technically important properties of fibres.
(b) The absorption of water by textile fibres.
(c) The elastic properties of fibres.
(d) The finishing of woollen and worsted fabrics.
(e) A theory of the colloid structure of fibres.

The Fibre Balance, by T. BARRATT.

A description was given of an improved apparatus, designed for the measurement of the breaking stress, extensibility and recovery from strain of single textile fibres, first described by the author in 1922. Some characteristic stress-strain diagrams were giv

Some Structural Characters of the Flax Fibre, by C. R. NODDER.

The structure of the fibres of flax were considered in detail and also the double refraction caused by the flax fibre. The author then went on to consider the very pronounced pleochroism which is shown by stained fibres, and also considered their twisting behaviour.

Recent Advances in the Experimental Study of Warp Sizings, by F. D. FARROW.

Although the art of sizing is very ancient and admirable results are usually obtained by well-trained workmen with long experience, it is impossible to specify exactly the qualities which the ingredients of the size should possess. In this paper the author advanced these qualities, and showed that continued development of recently described methods of examining textiles should enable their essential characteristics to be ascertained with exactitude.

A Review of Work on the Absorption and Desorption of Moisture by Textile Materials, by A. R. URQUHART and A. M. WILLIAMS.

The authors have shown that textile materials resemble other gels in their moisture relations, and exhibit a hysteresis which can be probably explained in terms of the capillary theory of gel structure. The effect of temperature on the moisture content at constant relative humidity was examined.

The Function of Water in Wet Spinning of Flax, by W. H. GIBSON.

The solubility of various flaxes was determined, and the function of water in wet spinning has been investigated.

Aircraft Fabrics, by J. E. RAMSBOTTOM.

This paper dealt with some of the properties of fabrics used for the structural covering of aircraft. The following were considered: Tautness, strength, deterioration or weathering, and protection from the deteriorating action of water.

The Action of Light on Textiles, by G. BARR.

The action of sunlight on the following textiles was investigated: Rubber balloon fabrics, doped linen fabric, silk, wool, artificial silks, ramie and jute. The effect of the diameter of the yarn was investigated, and it was shown that the nature of the physico-chemical changes produced in cotton and linen by the action of light is due in the main to oxidation.

Measurement of the Transparency of a Fabric, by THOMAS BARRATT, D.Sc., F.INST.P.

(A Contribution to a General Discussion on *Physical and Physico-Chemical Problems Relating to Textile Fibres*, held by the Faraday Society and the Textile Institute, at the British Empire Exhibition, Wembley, on Wednesday, June 11, 1924.)

The apparatus employed consisted of a special form of Joly's photometer. For measurements of transparency, the fabrics were pinned over the rectangular openings in blackened boxes containing lamps.

The total transparency was taken as the percentage of incident light transmitted by the fabric.

The "Thread Transparency" was the percentage of light falling on the threads alone which is transmitted by them.

THE MINERALOGICAL SOCIETY.

JUNE 17.

The following papers were read:—

PROF. MIKLOS VENDL, *The Chemical Composition and Optical Properties of a Basaltic Hornblende from Hungary.*

W. A. RICHARDSON, *On the Concretions in the Magnesian Limestone near Sunderland.*

SOCIETY OF GLASS TECHNOLOGY.

JUNE 18.

Papers read:—

Some Remarks on the Erection and Operation of Modern Tank Furnaces, by PERCIVAL MARSON.

Note on an Unusual Type of Recuperative Tank Furnace, by F. W. HODKIN, B.Sc., and PROF. W. E. S. TURNER, D.Sc.

THE PHYSICAL SOCIETY OF LONDON.

JUNE 13.

Papers read:—

On a Method for the Synchronous and Instantaneous Illumination of Objects Rotating or Vibrating at Very High Speeds, by DR. G. E. BAIRSTO, Royal Aircraft Establishment, Farnborough.

The Absorption and Scattering of γ-Rays, by DR. E. A. OWEN, MR. N. FLEMING, and MISS W. E. PAGE, The National Physical Laboratory.

The Flow of Compressible Fluids, Treated Dimensionally, by MR. W. N. BOND, M.Sc., University College, Reading.

Note on Israj, a Remarkable Indian Stringed Instrument, by MR. D. B. DEODHAR, University of Lucknow, India.

MAY 23. F. E. SMITH, C.B.E., F.R.S., IN THE CHAIR.

Papers read:—

The Magnetism of Annealed Carbon Steels, by PROF. S. W. J. SMITH, F.R.S., A. A. DEE, B.Sc., and W. V. MAYNEARD, M.Sc., University of Birmingham.

This paper is a sequel to one on the *Self-Demagnetisation of Annealed Steel Rods*, in which it was shown that the residual moment of a magnetised rod of annealed steel (of particular dimensions) does not diminish continuously towards zero as the temperature is raised, but changes sign at about 180°, reaches a maximum negative value at about 220°, and subsequently slowly falls until the temperature at which steel ceases to be ferromagnetic is attained.

Experimental evidence was adduced to show that the reversal is primarily due to the laminated structure of the iron-iron carbide "eutectoid" which the steel contains.

It was shown that the reversal disappears when this structure is destroyed, and an explanation of the fact that the effect is most pronounced in a steel containing the eutectoid percentage of carbon is given.

Some Thermo-Magnetic Properties of Nearly Pure Iron, by W. V. MAYNEARD, M.Sc., and A. A. DEE, B.Sc.

The Atomic Structure of Two Intermetallic Compounds, by E. A. OWEN, D.Sc., and G. D. PRESTON, B.A., National Physical Laboratory.

The two intermetallic compounds Mg_2Si and AlSb have been examined by the X-ray spectrometer with the following results:—

Mg_2Si.—*A face centred cubic lattice* of silicon atoms of side 6.391 A symmetrically intermeshed with a simple cubic lattice of magnesium atoms of side 3.19 A. There are eight magnesium atoms situated within each face centred cube of silicon atoms, dividing the four cubic diagonals in the ratio 1 : 3 and 3 : 1. Density from X-ray data 1.95 + 0.05 gms./c.c. The magnesium atoms are separated by the same distance as in the pure metal. The sum of the "radii" of silicon and magnesium atoms is equal to the distance between these atoms in the compound.

AlSb.—A face centred cubic lattice of antimony of side 6.126 A intermeshed with an identical lattice of aluminium atoms; the corner of the latter dividing the cubic diagonal of the former in the ratio of 1 : 3. Density from X-ray data 4.23 + 0.04 gms./c.c. The molecular volume of the compound is greater than the sum of the *atomic volumes of its constituents*. The increase in volume observed by the method of X-ray analysis agrees with that obtained by other methods of measurement. The volume of the lattice on which the antimony atoms are arranged is 4 per cent. less than the volume of the face centred rhomb found in pure antimony. The molecular volume of the compound is accordingly 4 per cent. less than twice the atomic volume of antimony. The closest distance of approach of aluminium and antimony atoms is 2.65 A, which is less than the sum of their "radii" as determined from the pure metals.

NOTICES OF BOOKS.

Chemical Enclcyopædia, by C. T KINGZETT, F.I.C., F.C.S. Pp. VIII. + 606. Third Edition. London: Messrs Bailliere, Tindall & Cox, 8, Henrietta St. W.C.2. 1924. 30s. net.

The latest edition of this encyclopædic dictionary, dedicated to Viscount Leverhulme, is more comprehensive than its pre

decessors, extending, as it does, to over 600 pages.

The author has evidently found the task of compilation and revision a very heavy one, and as a consequence, in one place at least, some of the type has been displaced, as the following account of *Actinium* will show: "Name of a radio-active substance resembling and being a product of the disintegration of Thorium; said to be the shortest-lived substance, having a life-period of one five-hundredth part of a second. It is obtained from uranium minerals (pitchblende), but no atomic weight has yet been assigned to it. Aqueous solutions of its salts slowly evolve hydrogen and oxygen in the proportions in which they exist in water" (p. 7). This definition, of course, does not fit actinium.

From a perusal of the definition of isotopes it might almost be concluded that their existence was purely speculative and was held only by enthusiastic workers in that field. The rapid advances made in this and other branches of science, however, make it difficult for a writer to keep abreast of the times, especially when so comprehensive a treatise is being prepared. The Atomic Weights given on p. 191 are apparently taken from those issued by the International Committee in 1921.

The information in subjects appertaining to industrial chemistry forms the most valuable part of the dictionary. It is items of this section that will be consulted by many professional men of callings beyond strictly scientific and chemical circles.

Kitāb Al-'Ilm Al-Muktasab Fi Zirā'at Adh-Dhahab. Book of Knowledge acquired concerning the Cultivation of Gold, by Abu' L-Qasim Muhammad Ibn Ahmad Al-'Iraqi. The Arabic text edited with a translation and Introduction by E. J. Holmyard, M.A., F.I.C. Pp. 62 + 63. Paris: Paul Geuthner, Librarie Orientaliste. Price 30 francs.

At the present time, when more and more facts are being discovered, and fresh theories are constantly advanced, revised or abandoned, it is good to look back on some of the earlier scientific work and thought. Mr. Holmyard has rendered science good service in editing and translating this early contribution to chemical literature. The debt to him and the publishers will be further realised when the trouble of setting Arabic type is recalled.

The original sources of Arabic chemistry have mostly still to be investigated. Only a few enthusiasts, *e.g.*, Berthelot, Wiedemann, and Ruska, have attempted the task of examining the works of Jâbir and the other early Islamic savants.

The main theme of the present volume is that all metals are in reality the same, differing only in unessential properties which can be removed by suitable treatment. (This was not universally accepted by Arabian alchemists at the time.) An endeavour is made to prove the possibility of transmutation. The residue of silver left after the cupellation of argentiferous lead is interpreted (wrongly) as a result of partial transmutation. Many of the simple chemical processes of to-day were known to the Arabian alchemists. Crystallisation was widely employed to purify bodies. It is interesting to note that the separation of crystals from a solvent was regarded as due to a "putrefaction" of the liquid. Part of the book is naturally fantastic, as, for example, the section describing the prime matter from which the form of the "Elixir" is derived. While this part has little value from the point of view of practical chemical knowledge, it is of importance as indicating the development of a line of alchemistic thought in Islam quite distinct from that which passes from Jâbir, through Rhazes to Spain, and thence to Europe.

As so few Arabic texts have been made avaiable for general readers (Mr. Holmyard gives what he believes to be a complete list of these few in the introduction), it is to be hoped that more volumes of this type will follow. J.G.F.D.

The Clarendon Press, Oxford, has just issued *Forestry Memoir No. 2*, entitled "Soil Acidity and its Relation to the Production of Nitrate and Ammonia in Woodland Soils," by G. R. Clarke, B.A., B.Sc.

Of the numerous bodies in the soil, none are so important for plant nutrition as those which undergo decomposition with the generation of the NO_3 ion. This is now found to express very well the acidity differences between various soils.

BOOKS RECEIVED.

The Structure of Matter, by J. A. Cranston, D.Sc., A.I.C. Pp. XV. + 196. 1924. Messrs. Blackie & Son, Ltd., 50, Old Bailey, E.C.4. 12s. 6d. net.

Chemical Thermodynamics, by J. R. Partington, M.B.E. Pp. VI. + 275. 1924. Messrs. Constable & Co., Ltd., 10-12, Orange Street, W.C.2. 10s. 6d. net.

Institut International d'Agriculture. Rome. Production et Consommation des Engrais Chimiques dans le Monde. Pp. VIII. + 266. 1924. Imprimerie de l'Institut International d'Agriculture.

BULLETINS ISSUED BY THE U.S. DEPARTMENT OF COMMERCE, BUREAU OF STANDARDS.

Investigations on the Platinum Metals. IV.—Determination of Iridium in Platinum Alloys by the Method of Fusion with Lead, by Raleigh Gilchrist. Pp. 325 to 345.

Gravitational Anisotropy in Crystals, by Paul R. Heyl. Pp. 308 to 334.

Application of the Interferometer to Measurements of the Thermal Dilatation of Ceramic Materials, by George E. Merritt. Pp. 357 to 373.

New Patents.

This list is specially compiled for *The Chemical News* by Messrs. Rayner & Co., Registered Patent Agents, of 5, Chancery Lane, London, from whom all information relating to Patents, Trade Marks, and Designs can be obtained gratuitously.

Latest Patent Applications.

12654—Coke, B. E.—Catalytic oxidation of paraffin hydrocarbons. May 23.

Abstract Published this Week.

213631—Cellulose acetate; artificial textile filaments.—Levy, L. A., 31, Shoot-up-Hill, Cricklewood, London.

Cellulose acetate, and processes for making filaments from.—To facilitate the separation of unchanged fibres and insoluble extraneous matters from cellulose acetate, more particularly such as is to be used in the manufacture of artificial filaments, the acetate, while in solution in the acetylation mixture, is subjected to hydrolysis to reduce the viscosity of the solution, and is then filtered; the acetate is subsequently recovered as such, by precipitation. The viscosity of the solution may be further reduced so as to render filtration still easier, by the addition of a limited quantity of water immediately before filtration.

Messrs. Rayner & Co. will obtain printed copies of the published specifications and abstract only, and forward on post free for the price of 1s. 6d. each.

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THE CHEMICAL NEWS,

VOL. CXXVIII. No. 3350.

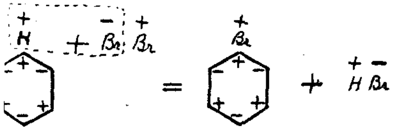
AN EXPLANATION OF THE THEORY OF THE REVOLUTION OF THE ATOMIC NUCLEUS.

PART VII.

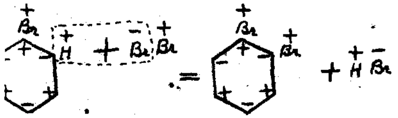
By HERBERT HENSTOCK.

AROMATIC SERIES.

Since the whole idea of nuclear rotation arose from a piece of practical organic research work, it may be as well to indicate the difficulties which suggested it. In the bromination of aromatic hydrocarbons the mechanism of the reaction, explained by the theory of induced alternate polarities of atoms, might be given as follows:—



On brominating mono bromo benzene the ortho and para compounds are formed, that is to say, the second bromine atom attaches itself to a negative carbon atom, thus:



Now, in this arrangement, there are two difficulties, which are not inherent in the theory of induced alternate polarities nor to any oversight in its application. These difficulties are as follows:—

(1) Why do positive bromine atoms attach themselves to positive carbon atoms? If atoms are alternately of opposite polarities this is an anomaly.

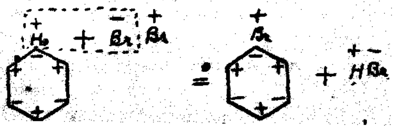
(2) Why should bromine first attack a positive carbon atom and thereafter attack only negative ones?

On closer inspection a third difficulty arises, which is also not due to any defect in the above theory or in its application, but is due to the fact that some underlying principle of the theory has not been explained. This difficulty is:—

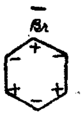
(3) What is a positive bromine atom?

Since two bromine atoms should be identical in their construction, there must be some cause *inherent in each atom* for one being positive and the other negative in the bromine molecule. The negative bromine atom is readily understandable from the Lewis-Langmuir conception of the electronic theory of valency, since bromine is a permanently negative element, at least in comparison with those to the left of it in the periodic table: but how is one going to envisage a positive atom of that element? The author has attempted, by means of the theory of nuclear rotation (*The Chemical News*, 1923, CXXVI., 129), to answer question (3), and in the light of that answer the difficulties in questions (1) and (2) vanish.

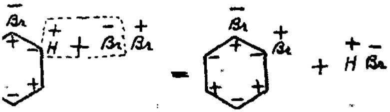
It must be remembered that, in the above reaction, the positive bromine atom is positive (1) in the bromine molecule, (2) during the transfer, and (3) when it enters the hydrocarbon molecule. What constitutes this atom as a positive one in cases 1 and 2? It cannot have left an electron with the negative atom and carry only six external electrons to the hydrocarbon, since in that case the bromo benzene would be an electron short. But, supposing this to happen, what *is* there in the negative bromine atom which permits it to retain this electron? The positive atom cannot share one or more electrons with any other atom *during the transfer*. There must then be something inherent in the bromine atom itself to allow of its positive polarity: this something may be the rotation of the nucleus, and if we apply this to the above reaction, remembering that the nuclear poles tend, like a magnetic needle, to set themselves in the most stable position with respect to the arrangement of the electrons, then no difficulties appear in the application of the theory of the induced alternate polarities of atoms. The above reaction may then be stated as follows:—



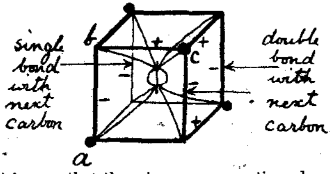
Positive bromine attaches itself to a negative carbon atom. The bromine in the bromo benzene is now the key atom, and is attached to carbon, which is a neutral element *in permanent polarity*: the nucleus of the bromine now revolves, making it alternately negative, which causes the nuclei of the carbon atoms to revolve all round the ring, thus:



so that when another positive bromine atom enters the ring it does so quite naturally in those positions, where the negative carbon atoms are situated, as



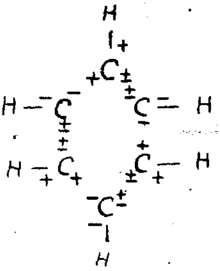
The first bromine atom is the key atom, which remains negative, but the second atom may be positive or negative. On drawing out the octet of the negative carbon atom, fig. 1,



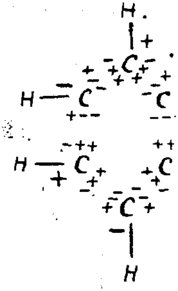
it is seen that there is a spare negative edge (a—b) and a spare positive edge (b—c), so that a second bromine atom, on union with such a carbon atom, might unite by its negative edge to the positive one (b—c) in the carbon; thus, all bromine atoms in bromo aromatic compounds would be equivalent in polarity; this, however, need not necessarily be the case.

HOMOCYCLIC RINGS.

In benzene, the bonds, according to Kekule's formula, would be labelled as A, or, in accordance with that expressed by Kermack and Robinson (*Trans.*, 1922, CXXI., 437) as B.

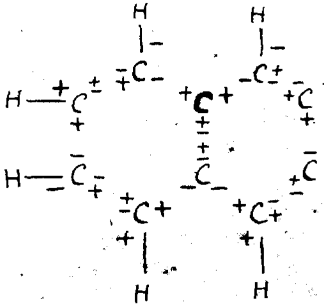


A.

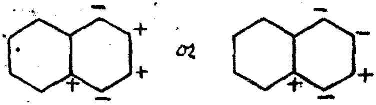


B.

This, extended to naphthalene, gives

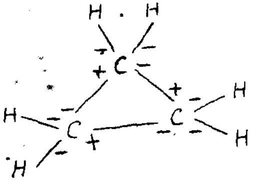


The C marked in dark ink is strongly positive, as shown by the authors mentioned above. There is in each carbon octet, whether linked in the ring as in A or B above, a spare positive and also a spare negative edge for a single bond union, so that, although the ring unions will be always correct, each carbon atom may link up by either edge to any atom or group entering the ring (see fig. 1); we may, therefore, have the phase in naphthalene



without violating alternate polarity, since these signs represent the single bond unions to substituting groups and not the alternate polarities of the ring; the polarities of these side unions are determined partly by the entering groups and partly by the whole molecule influenced by any groups which it may already contain.

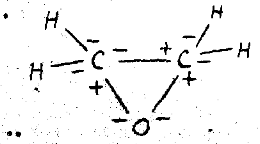
Trimethylene and similar rings are constituted thus:—



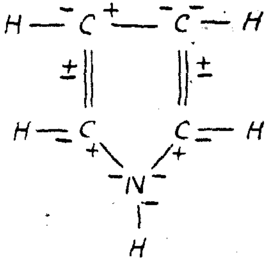
The carbon atoms are linked chiefly by negative bonds, but they have one single positive bond in each atom. This positive bond is weak (see Part VI.), hence the ease with which the trimethylene ring is broken. That the bonds outside the ring tend to be negative is shown by the readiness with which the carboxylic acids are formed.

Heterocyclic Rings.

Ethylene oxide



shows a similar weakness to that of trimethylene; its additive properties may be explained from the above formula. In pyrrole the weakness is near the nitrogen, i.e., in the α position; as



The two carbon atoms in the α position are linked up by both positive and negative bonds. The latter are easily changed to positive ones, hence the reactivity of these positions, especially to negative groups such as oxygen, alkyl, -COOH, etc.

In Conclusion.

It is very probable that the cubic form for the octets, which has been depicted throughout this series, is in many cases distorted, not in the sense in which the word was used in connection with the disappearance of a cube corner or face (Parts III. and IV.), but in the sense that the electrons at either end of a cube edge may be closer together or farther apart than a cube edge would demand. In many cases, especially in organic chemistry, and also in electro valencies throughout the science, the bonds may not necessarily be formed by the close juxtaposition of two cube octets, which may be, and probably are, at some distance from one another, so that the formulæ, here set out, must not be taken too literally; in some cases they were given more as a demonstration of the theory, in its application to orientation and alternate polarity than as an exact spacial representation of the molecules.

Also, especially with respect to carbon the octet form may not be strictly correct In carbon dioxide and the carbonates the full octet form is probably the right one but in carbon monoxide and many compounds in organic chemistry, the tetrahedral form may be the more probable one.

As a summary of the whole it may b stated that the nucleus of an atom controls its union with other atoms, by exert

ing its force upon the electrons of the octet and also upon one or more electrons of any other atom, with which it may unite: in certain directions (*i.e.*, negative ones) round the octet the accumulation of electrons in that octet is encouraged by the nucleus, and in other directions (*i.e.*, positive ones) the opposite effect is produced, so that the theory of nuclear rotation is in accord with many of the arguments employed by those who have used only the electrons of the octet to demonstrate alternate polarity and its effects, the chief difference being that the author labels the *bonds* positive or negative, instead of the atoms. Alternate polarity has been carried to its logical conclusion in that atoms are always united by opposite polar bonds, *such bonds being polar in the sense of weak* alternate polarity and not in that of permanent or electric polarity.

Any atom may unite with others by both positive and negative bonds occurring in the same atom at the same moment: atoms of a given permanent polarity tend to use those alternate polar bonds of the same sign.

The orientation is determined to a great extent by the permanent polarity, not only of the atom which actually links up to a molecule, but also by that of the atom in the molecule with which the link is made. The negative permanent polarity of an atom is slightly augmented on its union by a negative bond, that is by sharing the electrons of other atoms, and its positive permanent polarity is raised on its union by a positive bond, that is by its electrons being shared by other atoms.

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THE STRUCTURE OF SELENIUM.

By Hawksworth Collins.

In *The Chemical News*, 1920, CXXI., 57, a very large generalisation was given with regard to the number 23 in considering the constitution and structure of the elements as a whole. Selenium came into this generalisation as Na_2S, because 78 = 2 × 23+32.

The isotopic masses of Se, given by the Int. Com., 1923, are 80, 78, 76, 82, 77, 74, whilst the atomic weight is given as 79.2.

In *The Chemical News*, 1907, XCVI., 176, the discovery that, in general, elements of even valency have even atomic weight, and those of odd valency have odd atomic weight, was first published; and in vol. CVIII., 235, it was proved that the probability that this contains a truth is at least one million to one, *i.e.*, that there is no doubt at all about its truth.

As long as the atomic weight of Se, whose valency is even, was given as nearer to an odd than to an even number, this element appeared to be an exception to the general rule; but now that five out of the six isotopes are given as even numbers, the state of affairs is quite altered, and the following statement, which was made in *The Chemical News*, 1920, CXXI., 157, is *more than ever true*:—" When a state of affairs has been proved to be due to cause and not to chance, it is evident that no future discoveries or additions to knowledge (such as isotopes, *e.g.*), can ever contradict the general truth obtained, for it is impossible for scientists to unconsciously evolve a state of affairs which can be proved to be due to cause and not to chance, and yet for it not to contain an absolutely incontrovertible truth."

By continued work upon several such truths, which have appeared in *The Chemical News*, the deduction has been obtained that an atom of selenium has been formed by the addition of two atoms of sodium to one of sulphur in the following manner:—

$$\begin{matrix} Na \\ Na \end{matrix} \Big> Na - H - H_2 - H - H_2 - H$$

the valences of the two additional masses of 23 being mutually quiescent, as usual (*loc. cit.*), so that the valences of Se are exactly similar to those of S. (The two lines joining the Na_2 to the Na of sulphur are not valences, but internal atomic bonds.)

The presence of the other isotopes of mass 80, 76, 74, 77 and 82 appear at present to lead to complications, but there are already signs that these difficulties will gradually disappear. The following remark with regard to them seems to be fairly rational:—These isotopes are observed after exceedingly violent electrical operations upon electrical matter.

The laws of relative volume and of heat of formation will now be employed to prove

that the above constitution of an atom of selenium is correct.

TABLE I.

The Relative Volumes of Selenium at 15° C.

Se	=	Na	+	Na	+	S
21.29	=	0	+	5.76	+	15.53
17.43	=	1.9	+	0	+	15.53
15.53	=	0	+	0	+	15.53
18.36						
18.17	=	1.9	+	5.76	+	10.51
16.27	=	0	+	5.76	+	10.51
14.31	=	1.9	+	1.9	+	10.51
11.31	=	1.9	+	1.9	+	7.51

It is unnecessary to apologise for the large number of volumes, since four of them are obtained directly from the uncombined element. 1.9 and 5.76 are volumes of Na only when forming part of an element; they will be shown to be constituent parts of other elements later.

TABLE II.

Experimental data demonstrating the volumes of Table I.

		Relative Volumes.	Theor. S.G. at 15° C.	Obs. S.G.	
(84)	Se	16.27	4.794	4.796	Schaffgotsch
(85)	Se	17.43	4.475	4.47	25° Nostrand
(86)	Se	18.17	4.293	4.297	Schaffgotsch
				4.28	Rathke
(87)	Se	18.36	4.248	4.245	to 4.250 Schaffgotsch
(88)	SeO_2 (solid)	21.29 + 2.51 + 4.45	3.9	3.95	15° Nostrand
(89)	SeS	21.29 + 15.53	3.0	3.056	0° Little, *i.e.*, 3.02 15°
(90)	PbSe	20.45 + 21.29.	6.80	6.8	Zinken
(91)	SnSe	16.1 + 21.29	5.242	5.24	15° Schneider
(92)	Se_2Cl_2	17.43 + 21.29 + 23.01 + 15.085	2.95	2.906	17°.5 Divers, *i.e.*, 2.914 15°
(93)	SnSe	16.1 + 15.53	6.197	6.179	0° Nostrand
(94)	$SeOCl_2$	18.36 + 2.51 + 2(23.01)	2.467	2.443	13° Michaelis
(95)	PbSe	17.42 + 18.36	8.00	8.10	15° Nostrand
(96)	CdSe	14.56 + 18.17	5.78	5.80	Margottet
(97)	$SnSe_2$	16.1 + 21.29 + 16.27	5.106	5.133	Little
				4.85	Schneider
(98)	Ag_2Se	2(10.1) + 16.27	8.0	8.0	Rose
(99)	As_2Se_2	2(11.38) + 2(21.29) + 16.27	4.705	4.752	Little
(100)	Ag_3As	3(10.1) + 11.38	9.50	9.51	Descamps
(101)	Se_2Br_2	16.27 + 21.29 + 27 + 23.09	3.605	3.604	15° Schneider
(102)	Bi_2Se_3	2(21.29) + 16.27 + 2(18.36)	6.82	6.82	Nostrand
(103)	PbSe	20.45 + 14.31	8.17	8.154	Little
(104)	Cu_2Se	2(9.54) + 11.31	6.71	6.71	Nordenskiold
(105)	Fe_2Se_3	2(10.08) + 3(11.31)	6.39	6.38	Little
(106)	Fe_2O_3	2(10.08) + 2(4.45) + 2.51	5.07	5.079	Neumann

TABLE III.

Heat of Formation of Selenium.

	H.F.							Original Volume		Rel. Vol. in combination 15° C.		Change of Volume.
(a)	46380	=	120	×	4.96	×	78	16.27	=	11.31	+	4.96
(b)	-1778	=	120	×	(-0.19)	×	78	18.17	=	18.36	-	0.19
(c)	-46987	=	120	×	(-5.02)	×	78	16.27	=	21.29	-	5.02
(d)	-10858	=	120	×	(-1.16)	×	78	16.27	=	17.43	-	1.16
(e)	18360	=	120	×	1.96	×	78	16.27	=	14.31	+	1.96
(f)	26534	=	120	×	2.83	×	78	18.36	=	15.53	+	2.83
[illegible]	[illegible]	=	120	×	0.74	×	78	16.27	=	15.53	+	0.74

TABLE IV.

Examples illustrating *Table III.*

				Theor.	Obs.	
H.F. solid	CoSe	−32920 + 46380	=	13460	13900	pp. 9900 cryst.
,,	Cu_2Se	2(−19080) + 46380	=	8220	8000	
,,	CdSe	−23200 + 46380	=	23180	23700	
,,	PbSe	18500 − 1778	=	16722	17000	cryst. 14300 pp.
,,	SrSe	69239 − 1778	=	67461	67600	
,,	SrH_2	69239 − 2(15300)	=	38639	38400	
,,	BaSe	72134 − 1778	=	70356	69900	
,,	BaS	72134 + 30681	=	102815	102900	
,,	Li_2Se	2(42570) − 1778	=	83362	83000	
,,	CaSe	59568 − 1778	=	57790	58000	
,,	$SeCl_4$	−46987 + 4(23010)	=	45053	46160	
,,	H_2SeO_4	2(−15300) − 46987 + 2(71515 + 32341)	=	130125	128220	
,,	H_2SeO_3	3(−24350) − 46987 + 96155 + 71515 + 32341	=	79979	79300	
H.F. aq.	SeO_2	−46987 + 71515 + 32341	=	56869	57080	56840
,,	SeO_3	−46987 + 3(32341)	=	50036	48800	
H.F. liq.	Se_2Cl_2	−10858 − 46987 + 23010 + 56786	=	21951	22150	
H.F. aq.	H_2SeO_2	2(−15300) + 18360 + 2(32341)	=	52442	52400	
,,	H_2SeO_3	2(−15300) + 18360 + 2(32341) + 71515	=	123957	124500	
H.F. solid	NaHSe	32706 − 15300+18360	=	35766	35300	
H.F. liq.	NaHSe	32706 − 24350+26534	=	34890		
H.F. aq.	H_2SeO_4	2(−24350) + 26534 + 3(32341) + 71515	=	146372	145020	
,,	Na_2SeO_4	2(32706) + 26534 + 3(32341) + 71515	=	260484	262300	
,,	NaHSeO	32706 − 24350 + 26534 + 3(32341) + 71515	=	203428	203200	
,,	SrSe	67950 + 6926	=	74876	75000	
,,	$SrBr_2$	67950 + 2(52930)	=	173810	173810	Thomsen
,,	NaBr	32706 + 52930	=	85636	85800	Thomsen
,,					85580	85910

The following paragraphs: (a), (b), (c), and (d) demonstrate the connection between Tables II., III., and IV.:—

(a) Take selenium of specific gravity 4.794, and copper of S.G. 8.97, in order to form Cu_2Se. Its R.V. is 2(9.54) + 11.31 (No. 104, Table II.); and its H.F. is 2(−19080) + 46380 = 8220; 8000 (obs.), where −19080 = 120 × (−2.52) × 63, 9.54 − 2.52 = 7.02, and 63 ÷ 7.02 = 8.97; 8.96 Berzelius.

(b) Take selenium of S.G. 4.293, and lead of S.G. 11.34, in order to form PbSe. Its R.V. is 17.42 + 18.36 (No. 96, Table II.); and its H.F. is 18500 − 1778 = 16722; 17000 (obs.), where 18500 = 120 × 0.75 × 206, 17.42 + 0.75 = 18.17, and 206 ÷ 18.17 = 11.34; 11.346 Crichton.

(c) and (d) Take Se of S.G. 18.86 and form Se_2Cl_2. Its R.V. is 17.43 + 21.29 + 23.01 + 15.085 (No. 92, Table II.); and its H.F. is − 10858 − 46987 + 23010 + 56786 = 21951; 22150 (obs.), where 56786 = 120 × 13.325 × 35.5, 28.41 = 15.085 + 13.325, and 23010 = 120 × 5.4 × 35.5, 28.41 = 23.01 + 5.4.

Both these volumes of Cl, 15.085 and 23.01, have frequently been given in previous papers, and they confirm one another by giving the same original volume, 28.41.

(e), (f) and (g) are cases of H.F. in aqueous solution, so that the relative volumes cannot be ascertained from specific gravity.

The volume of SeO_2 in aqueous solution must be 21.29 + 4.45 + 7.53 according to its H.F. aq. in Table IV., and its volume as a solid is 21.29 + 4.45 + 2.51 from Table

II., so that in changing from the aqueous to the solid state only one of its three atoms is altered. The fully extended oxygen atom of volume 7.53 withdraws its two helium portions within its metallic part and becomes an atom of volume 2.51.

Table V. leads up to the volume of each atom in the solid metallic selenates, of which there are unfortunately no experimental values of heat of formation available.

TABLE V.

H_2SeO_3 aq.	2(5.76) + 14.81 + 2(7.53)	from Table IV.
H_2SeO_3 aq.	2(5.76) + 14.31 + 2(7.53) + 4.45	,,
Na_2SeO_4 aq.	2(11.85) + 15.53 + 3(7.53) + 4.45	,,
SeO_3 aq.	21.29 + 3(7.53)	,,
SeO_2 aq.	21.29 + 7.53 + 4.45	,,
SeO_2 *solid*	21.29 + 2.51 + 4.45	from Table II.
Na_2SeO_4 solid	2(11.85) + 21.29 + 2(2.51 + 4.45)	gives S.G. 3.19, 3.098 Topsoe, 3.217 Pettersson
K_2SeO_4 solid	2(18.05) + 21.29 + 2(2.51 + 4.45)	gives S.G. 3.085, 3.077 21° Pettersson
Rb_2SeO_4 solid	2(22.29) + 21.29 + 2(2.51 + 4.45)	gives S.G. 3.91, 3.902 20°/4 Tutton, 3.928 Topsoe
$SrSeO_4$ solid	19.56 + 21.29 + 2(2.51 + 4.45)	gives S.G. 4.20, 4.23 Michel
Tl_2SeO_4 solid	2(22,29) + 21.29 + 2(2.51 + 4.45)	gives S.G. 6.89, 7.019 18° Pettersson 6.875 20°/4 Tutton
NaCl	11.85 + 15.095	gives S.G. 2.17, 2.17 20° Kaye
K_2S	2(18.05) + 15.53	gives S.G. 2.130, 2.130 Filhol
RbBr	22.29 + 27	gives S.G. 3.35, 3.358 Setterberg
SrI_2	19.56 + 2(27.75)	gives S.G. 4.556, 4.55 25°/4 Nostrand
Tl_2S	2(22.29) + 10.51	gives S.G. 8.00, 8.00 Lamy

he volume 20.45 of Pb in Table II. is a mon one, but does not happen to have sared *before*; and the 10.08 of Fe is usual volume of triadic iron. All other theoretical values given in Tables II. and IV. are supported either here or in previous papers. 9.54 for Cu will be employed frequently in the future as its most common volume, instead of 9.74, which was given in *The Chemical News*, 1922, CXXV., 82, and its H.F. is −19080 *instead* of −20083.

In Table III., 18.36 is a volume of Se; 18.36 is a value of H.F. in large calories; 9.54 is a volume of Cu; and (−19080) = 2(−9.54) is a value of its H.F., 23.01 is a volume of Cl, and 23.01 is a value of its H.F.

SUMMARY.

The above facts strengthen one or other of the four discoveries mentioned in the last paper, and at the same time prove that Se equals Na_2S. They also demonstrate that one or both of the Na portions may be drawn completely within the metallic part of S, and that the two helium portions of its sulphur-constituent may also be absorbed by this metallic part. *E.g.*, when Se has the volume 16.27 = 5.76 + 10.51, one Na and the two helium portions, 2(2.51), have all disappeared *completely* within the metallic portion, 10.51, of S.

There is one important part of the problem which *cannot* be demonstrated in this paper, viz., that 1.0 and 5.76 each represent Na. This can only be accomplished by means of facts with regard to other elements.

PROCEEDINGS AND NOTICES OF SOCIETIES.

THE ROYAL SOCIETY.

JUNE 26.

Papers read:—

J. W. NICHOLSON, F.R.S. *The Electrification of Two Parallel Circular Discs.*

J. F. FULTON. *The Influence of Initial Tension upon the Magnitude and Duration of the Mechanical Response in Skeletal Muscle.* Communicated by Sir Charles Sherrington, P.R.S.

J. R. H. Coutts, E. M. Crowther, B. A. Keen, and S. Oden. *An Automatic and Continuous Recording Balance. (The Odén-Keen Balance).* Communicated by Sir John Russell, F.R.S.

R. W. Lunt, Ph.D. *Chemical Studies in Gaseous Ionisation: Part I. and Part II.* Communicated by Prof. F. G. Donnan, F.R.S.

D. W. Dye. *A Self-Contained Standard Harmonic Wavemeter.* Communicated by Sir Joseph Petavel, F.R.S.

Papers read in title only:—

W. L. Bragg, F.R.S. *The Influence of Atomic Arrangement on Refractive Index.*

G. S. Currey. *The Colouring Matter of the Blue Pansy.* Communicated by Sir Frederick Keeble, F.R.S.

R. Snow. *Conduction of Excitation in Stem and Leaf of Mimosa pudica.* Communicated by Dr. A. Church, F.R.S.

R. Azuma. *Thermodynamic Phenomena exhibited in a Shortening or Lengthening Muscle.* Communicated by Prof. A. V. Hill, F.R.S.

H. Taylor. *The Ionic Nature of Hæmoglobin.* Communicated by Prof. A. V. Hill, F.R.S.

Prof. A. V. Hill, F.R.S., and H. S. Gasser. *The Dynamics of Muscular Contraction.*

J. Stephenson, D.Sc. *On the Blood-Glands of Earth-worms of the genus Pheretima.* Communicated by Prof. J. H. Ashworth, F.R.S.

H. Muir Evans. *Supplementary Note on the Poison Gland of Trygon.* Communicated by Dr. H. H. Dale, F.R.S.

E. M. Crowther and A. N. Puri. *The Indirect Measurement of the Aqueous Vapour Pressure of Capillary Systems by the Freezing Point Depression of Benzene.*

Communicated by Sir John Russell, F.R.S.

B. Cavanagh. *Activity-Measurement by the Partition Method. I.* Communicated by Prof. J. W. Nicholson, F.R.S.

J. E. Jones, D.Sc. *On the Determination of Molecular Fields. Part I. and Part II.* Communicated by Prof. S. Chapman, F.R.S.

C. J. Smith. *An Experimental Study of the Viscous Properties of Water Vapour.* Communicated by Prof. H. C. Callendar, F.R.S.

E. M. Crowther and J. R. H. Coutts. *Discontinuity in the Dehydration of Certain Salt Hydrates.* Communicated by Sir John Russell, F.R.S.

W. R. Dean. *The Elastic Stability of an Annular Plate.* Communicated by Prof. G. I. Taylor, F.R.S.

R. C. Johnson and W. H. B. Cameron. *The Effect of Argon on certain Spectra.* Communicated by Prof. T. R. Merton, F.R.S.

G. R. Goldsbrough, D.Sc. *On the possible Ellipticity of Saturn's Ring.* Communicated by Prof. T. H. Havelock, F.R.S.

E. C. Titchmarsh. *The Double Fourier Series of a Discontinuous Function.* Communicated by Prof. G. H. Hardy, F.R.S.

THE CHEMICAL SOCIETY.

June 19.

Papers read:—

Hydrolysis, and the Theory of Induced Alternate Polarities, by D. R. Boyd.

The theory of induced alternate polarities has recently been made the basis of a comprehensive generalisation with regard to the phenomena of hydrolysis.

Its application to compounds of the type RX, where X is a halogen, leads to conflicting results. The hypothesis also fails to explain why compounds such as

$$\overset{+}{(}C_6H_5\cdot\overset{-}{O}\cdot\overset{+}{C}H_2)_2CH \; : \; \overset{-}{O}\cdot\overset{-}{P}HO(OH)$$

are much more stable than

$$\overset{-}{C}H_3 : \overset{-}{O}\cdot PHO(OH).$$

It is considered unlikely that the mechanism of hydrolytic fission is the same in all cases. The first step in the hydrolysis of PCl_5 probably consists in the formation of an additive compound:

$$PCl_5 + H_2O = P\begin{matrix} Cl \\ Cl \\ Cl \\ H \\ OH \end{matrix} = P\begin{matrix} Cl \\ Cl \\ OH \end{matrix} + HCl$$

The hydrolysis of PCl_5 may involve, on the other hand, a dissociation into PCl_4 and Cl ions:

$$\overset{+}{PCl_4}+\overset{-}{Cl}+\overset{+}{H}+\overset{-}{OH} = PCl_4\cdot OH+\overset{+}{H}+\overset{-}{Cl}$$
$$PCl_4:OH = POCl_3+HCl$$

The application of the theory to explain the effect of the orientation of the CH_3 group on the degree of hydrolysis of the sodium tolyloxides was also considered.

There was a long discussion on the cases which the theory of induced alternate polarities had not yet explained or accounted for.

The Isomerism of the Oximes. Part XX. The Isomeric p-*nitrobenzophenoneoximes and the Four Methyl Ethers derived from them*, by O. L. Brady and R. P. Mehta.

The stereochemical hypothesis of the isomerism of the oximes demands the existence of four isomeric ethers, an oxygen and nitrogen ether corresponding with each of the two isomeric oximes. Although two isomeric O-ethers had been obtained from certain aldoximes and ketoximes, until 1918 all attempts to obtain a second N-ether had been unsuccessful. Semper and Lichtenstadt (*Ber.*, 1918, LI., 928), however, prepared two N-methyl ethers from phenyl-*p*-tolylketoxime, but, though they isolated two O-methyl ethers, one was an uncrystallisable oil and consequently of doubtful purity. The importance of this in relation to the structure of the oximes demanded confirmation, and the isomeric *p*-nitrobenzophenoneoximes have now been prepared, and from them four distinct, crystalline, methyl ethers. *anti-p*-Nitrobenzophenoneoxime (1) on methylation gives a yellow crystalline N-methyl ether, m.p. 148° and a colourless crystalline O-methyl ether, m.p. 94°. *syn-p*-Nitrobenzophenoneoxime (2) gives a yellow crystalline N-methyl ether, m.p. 176°, and a colourless crystalline O-methyl ether, m.p. 97°.

$$\begin{matrix} NO_2:C_6H_4:C:C_6H_5 \\ \Vert \\ NOH \\ (1) \end{matrix} \qquad \begin{matrix} NO_2:C_6H_4:C:C_6H_5 \\ \Vert \\ HON \\ (2) \end{matrix}$$

The constitution of the ethers was proved by the action of hydriodic acid, the O-ethers giving methyl iodide and the N-ethers methylamine. The molecular weights were normal in every case. The two N-ethers differ in crystalline appearance as do the two O-ethers; addition of a small quantity of one N-ether to the other lowers its melting point, and the same is the case with the two O-ethers, a mixture of about equal quantities of the latter melting at 64-72°.

The Significance of Simple Rotatory Dispersion, by T. M. Lowry and E. M. Richards.

The phenomenon of simple rotatory dispersion was discussed in the light of new experimental data, with reference especially to camphorquinone, ammonium bromocamphor-π-sulphonate and methyl*cyclo*hexylideneacetic acid.

THE FARADAY LECTURE.

Prof. Millikan delivered the twelfth Faraday Lecture on June 12, at the rooms of the Royal Institution, Albemarle Street, Prof. W. P. Wynne, President, in the chair.

The lecturer began by giving an account of our present knowledge concerning various physical phenomena. The existence of the electron is no longer a matter of theory, but is an established fact. The "oil-drop" experiment has proved that an electric charge can vary only within certain limits.

The positive electron had a charge 1,800 times as large as that carried by the negative electron. Another fact was that the positive electricity was concentrated on the small nucleus of the atom, and was equal in quantity to that of the negative electrons. Appreciative reference was made to Moseley's work on atomic numbers, and an account was given of the recent developments in this fruitful field of research.

Prof. Wynne then presented the Faraday Medal to Prof. Millikan, in recognition of his discoveries. A vote of thanks to the

lecturer was moved by Prof. Donnan and seconded by Sir O. Lodge, and was carried with acclamation.

STUDIES IN THE REACTIONS OF THE AMINO GROUP IN 4' AMINO 1 PHENYL 5 METHYLBENZOTHIAZOLE.

PART IX.—AZO DYES FROM NITRODEHYDROTHIOTOLUIDINE.

By R. F. HUNTER.

In the previous part of this series of papers on the reactivity of the amino group in dehydrothiotoluidine, the preparation of a number of azo dyes derived from the thiazole by diazotising and coupling with suitable couplers in acid solution was described (*loc. cit.*). The purpose of investigating the preparation of these dyes was twofold; firstly, it was to obtain further insight into the reactivity of the amino group in the benzothiazole, and secondly, to investigate the chromophoric effect of the thiazole ring in combination with the six-membered homocyclic ring in the bicyclic system of benzothiazole. For this reason the work on thiazole dyestuffs is being further pursued.

Since nitrodehydrothiotoluidine contains the same amino group as dehydrothiotoluidine, it occurred to the author that nitrodehydrothiotoluidine might be capable of yielding azo dyes resembling those of dehydrothiotoluidine by the normal process of diazotising and coupling with suitable couplers.

A perusal of the literature of the subject did not reveal that the nitro thiazole had been used as a dye intermediate. A diazonium solution of the nitro thiazole was therefore prepared and coupled with a number of couplers. It was found that the naphthols and resorcinol and salicyclic acid gave good yields of azo compounds, which appeared to be similar to those previously obtained in the case of the parent substance, dehydrothiotoluidine itself, and those four substances were therefore chosen as suitable couplers. They are especially suitable, since they were the four couplers used in the preparation of azo derivatives of dehydrothiotoluidine (Part VIII), and therefore the azo compounds so obtained can be fairly compared with those derived from the parent amino compound.

With regard to nitrodehydrothiotoluidine it is to be expected that the introduction into the molecule of a nitro group in the parent substance will have the effect of producing a marked deepening of colour of the azo compounds derived from the amine.

The coupling was found to be less smooth than in the case of dehydrothiotoluidine, the azo compounds to be of the same colour as those derived from the parent thiazole, but deeper in colour. The azo compounds from the present experiments, anyhow, do not appear to be in any way improved. The trouble, it is possible, may lie in the fact that the nitro compound used was the crude *nitration product, and this, no doubt,* contains a small quantity of tarry material which appears to be produced during the *process of nitration.*

In any case, the nitro compound, in the form obtained by direct nitration, does not yield the clear diazonium solution which dehydrothiotoluidine itself does when diazatised in a strongly acid solution or suspension, and there would appear little doubt that this is to be attributed to a small amount of tar or potential tar, which is, of course, concealed in the water precipitation of the acid solution. The azo compounds prepared as hereunder by coupling in an acid solution exhibit the same insolubility as met with in the thiazole dyes previously prepared (*loc. cit.*).

The dehydrothiotoluidine used was the industrial intermediate, which contains appreciable quantities of primuline, but this in the case of dehydrothiotoluidine itself does not appear to exert a deteriorating influence on the resulting azo compounds. The four azo compounds prepared were those obtained by coupling with resorcino the naphthols and salicylic acid, and should have the structures (1), (2), and (3).

$$CH_3C_6H_3 <\begin{smallmatrix}S\\N\end{smallmatrix}> C\ C_6H_4N_2C_6H_3(OH)_2.$$

(1)

$$CH_3C_6H_3 <\begin{smallmatrix}S\\N\end{smallmatrix}> C\ C_6H_4N_2C_{10}H_6OH.$$

$$CH_3C_6H_3 < {}^{S}_{N} > C\,C_6H_4N_2C_6H_3(OH)COOH$$

(3)

The nitro compound was prepared by nitrating the thiazole with concentrated acid at ordinary temperature. From recent work on the preparation of the nitro compound, it appears highly probable that the nitration was complete. When using ordinary acid and not fuming, it is advisable to warm half an hour or so on a boiling water bath. In any case, the experiments indicated that the character of the resulting thiazole dyes was not improved by the introduction of the nitro group, and hence up to the present, the work has not been repeated, although it is hoped to carry out the work under better conditions, using pure dehydrothiotoluidine nitrated with fuming acid, and the coupling carried out in an alkaline solution, at a later date.

Experimental.

Nitration of Dehydrothiotoluidine:

15 gms. of dehydrothiotoluidine, in the form of a fine powder, are weighed into a 140 cc. beaker, and 25 ccs. of concentrated nitric acid run in from a burette with rapid stirring. A deep brown solution results with the production of heat and the evolution of nitrous fumes. The beaker is allowed to stand at room temperature for an hour, and the contents then poured into a litre of cold water, when a brilliant orange yellow precipitate separates out, which is filtered at the pump, washed and dried. Yield, 23 gms.

Nitrodehydrothiotoluidine Azo Resorcinol:

5 gms. of the above product are dissolved in 40 ccs. of concentrated nitric acid, and the solution diluted to 100 ccs. with ice water and small pieces of clean ice. The solution is then cooled in a freezing mixture until its temperature is 0° C. The theoretical sodium nitrite in 30 ccs. of ice water is then run in slowly from a tap funnel with steady stirring, the liquid being stirred a minute or two after the complete addition.

To the diazonium nitrate solution, the theoretical resorcinol in 30 ccs. of 2N sodium hydroxide, previously cooled in ice, is slowly run with stirring. The red azo compound separates at once. The beaker is left for half an hour in the freezing mixture. At the end of this time, salt is added, the beaker allowed to stand for some time, and the contents then filtered, washed with water and with dilute alcohol, and dried.

The dried azo compound is then digested with hot water for a few minutes, to remove the last traces of salt, filtered and dried on the steam after washing with a little alcohol. Yield, 4.8 gms.

The compound was examined as the azo compound from the parent thiazole (*loc. cit.*).

Examination.—The colour of the azo compound is a darker red than 1 phenyl 5 methylbenzothiazole 4′ azo resorcinol. The substance dissolves to a certain extent in hot glacial acetic acid. Concentrated sulphuric acid gives a deep red solution. A red solution is produced with caustic soda.

Nitrodehydrothiotoluidine Azo α-Naphthol:

5 gms. of the nitro compound were diazotised by dissolving in nitric acid, as above, diluting with ice and ice water, and running in the necessary sodium nitrite, the solution being cooled in a freezing mixture. To the diazonium nitrate was then added the theoretical naphthol in 30 ccs. of caustic soda after previous cooling, and the solution stirred. The red azo compound separated at once, the beaker was allowed to stand, salt added, the mixture allowed to stand, the azo compound filterel and washed, dried, and then digested with hot water, filtered, and washed with a little alcohol. Yield, 5.8 gms.

Examination.—The azo compound is a dark red solid, which gives a deep black solution with concentrated sulphuric acid, which displays bottle green fluorescence in ordinary daylight. The solubility in acetic aci dis poor. Sodium hydroxide produces a brown suspension.

Nitrodehydrothiotoluidine Azo β-Naphthol:

5 gms. of the nitro compound were diazotised as above, the theoretical naphthol in caustic soda solution run in, the azo dye salrted out, washed after filtration, dried, digested with hot water, and finally washed with alcohol and dried. Yield, 5.6 gms.

Examination.—Sulphuric acid produces a deep brown solution with the red azo compound. The azo compound is fairly soluble in hot glacial acetic acid. The azo compound gives a brown suspension with caustic soda solution.

Nitrodehydrothiotoluidine Azo Salicylic Acid:

5 gms. of crude nitro derivative were diazotised and coupled with the theoretical salicylic acid in caustic soda solution, the azo compound salted out, washed, dried, digested with hot water, washed with alcohol after filtration, and dried. Yield, 4.7 gm.

Examination.—Red solutions or suspensions resulted with sulphuric, nitric, hydrochloric acids and caustic soda solutions.

In conclusion, we might say that the azo compounds are darker than those in the case of dehydrothiotoluidine, the effect being attributed to the entrance of the nitro group into the homocyclic ring of the benzothiazole fused ring system. This, however, does not appear to improve the qualities as a dye intermediate.

April, 1924.

GENERAL NOTES.

CANADIAN PLUMBAGO DEPOSITS.

Canada possesses one of the largest known deposits of graphite, or plumbago. This deposit is situated near the village of Calabogie, in Eastern Ontario, about 75 miles from Ottawa, and is owned and operated by the Black Donald Graphite Company. It was discovered in 1896, and has been worked more or less steadily since that year. At the time of writing (January, 1924) it is the only graphite mine in operation in Canada.

The Black Donald deposit presents several features that single it out from the general run of graphite deposits. Chief of these are its size and the richness of the ore. Most of the known deposits of flake graphite are either graphite schists or gneisses, or graphitic crystalline limestones. In such deposits, the graphite occurs as individual flakes disseminated throughout the rock, the actual content of graphite usually ranging from 3 to 15 per cent. The flake graphite bodies of Alabama are probably the lowest in graphitic carbon content of any deposits that it has proved profitable to work, the average graphite content being 3 per cent. The Pennsylvania and New York deposits run about 5 per cent., while the Canadian deposits commonly range from 8 to 15 per cent. The ore from the Black Donald mine, however, averages 65 per cent. graphite, and in the richer zones may go as high as 80 per cent. It is a dense, compact aggregate of fine graphite flakes, containing subordinate amounts of mica, chlorite and calcite as the principal impurities. The ore-body is a vertical, vein-like mass of graphite, with a maximum width of 70 feet, lying between white crystalline limestone walls: it has been traced for more than 800 feet, but the vein and most of the underground workings lie under a lake, and the full extent of the deposit is unknown.

Some of the rich ore is shipped in the crude state, but the bulk of it undergoes a milling and refining process at the mine. The ore consists of a mass of fine graphite flakes, too small for the requirements of the crucible trade — the largest graphite consuming industry. With this flake occurs a small amount of very fine, dense graphite, with little lustre, that is commonly referred to as amorphous graphite. The amorphous material is separated in the refining process and utilised for products requiring only a low grade of graphite. The flake, owing to its freedom from gritty impurities which commonly contaminate the schist or gneiss graphites and are difficult to entirely remove even by the most careful milling, is greatly in demand for high-class lubricants. By modern methods of oil flotation, the Black Donald Company makes refined flake graphite running as high as 98 per cent. graphitic carbon—without question the purest natural graphite on the market.

The Company's market is confined almost entirely to the lubricating and foundry facing trades, and is mainly in the United States; but, since the highly successful policy of putting up high-carbon dry flake in package form was adopted, an increasing domestic business is being done, the graphite being employed extensively for automobile lubrication. The Company has also of late established agencies for their products in Great Britain, where Black Donald graphite is already meeting with a very favourable reception.

While the Canadian graphite-mining industry, as a whole, is in a very depressed state at the present time, owing to conditions in the crucible trade and competition from the cheaply-won Madagascar graphite, it is well to keep in mind that Canada has very important graphite resources and can

furnish large amounts of excellent flake graphite for crucible or other purposes. Moreover, recent improvements in methods of concentrating and refining enable the ore to be treated at a much lower cost than heretofore, and, in addition, give products of much higher grade.

CUMARIN RESIN.

This substance is said to be a by-product in the distillation of the early fractions from tar, especially when there is over-heating towards the end. The resin is obtained during the purification of the crude oils with sulphuric acid. This leads to the separation of polymerised products which, on further distillation, yield a more or less solid resin, cumarin resin.

Since different raw materials are employed, these resins show varying properties. Thus, some are adhesive in nature, others are not. They are usually brittle, and can be easily melted. The colour varies from yellow to dark brown, or black. The lighter varieties melt between 42-50° C., the brown kinds at 55-65° C., and the darkest was found to melt at temperatures between 80-105° C.

The uses of these resins is extending. Some have found application as adhesives, and in the composition of cements; others have been added to varnishes and in the making of paints. The lighter ones are of special value in the preparation of so-called metal paints, copper-bronzes, silver and gold colours. It should be noted that the resins are almost acid-free, and have no action on the colours with which they are admixed.

NOTICES OF BOOKS.

The Concentration of Sulphuric Acid, by J. W. Parkes, M.Sc., A.I.C. Vol. III. Pp. XII. + 424. London: Messrs. Gurney & Jackson, 33, Paternoster Row, E.C.4. 1924. 31s. 6d. net.

In volume III. of the new revised edition of Lunge's *Sulphuric Acid and Alkali Manufacture* the account of the concentration of sulphuric acid has been very substantially revised. In this process especially, much new experience was gained during the war, and the great proportion of the text is new.

It is remarkable that such a fundamental industry as sulphuric acid manufacture has remained, except for many minor improvements, substantially the same as regards process for so long a period.

Concentration has been effected in vessels of lead, glass, platinum, iron and its resistant ferrosilicon alloys, and vitreosil (silica). All the various methods and arrangements are described and discussed in great detail.

The importance of the arrangement and construction of the plant has been fully realised, and the author has also added to the excellence of this volume of the invaluable series by including appropriate statistics which are presented in a very interesting manner.

Standard Methods of Testing Petroleum and its Products. Pp. X. + 100. London: The Institution of Petroleum Technologists, Aldine House, Bedford Street, Strand. 1924. 6s. net.

The Institution of Petroleum Technologists is to be congratulated upon the publication of this little volume on Standard Methods for testing Petroleum and its Products, as determined by a committee it appointed for the purpose.

Complete international uniformity in methods of analysis is a very desirable aim, but, as pointed out, this is not always attainable at once. Thus it has been decided to retain the Abel flash-point method and the Redwood viscosimeter, although these are not in universal use. (They are, however, recognised throughout the British Empire.) The present volume is a very welcome step in the right direction.

The standardisation of nomenclature has not been reported upon, but the committee consider that there is a need for some action to be taken in the matter.

The book embodies the findings and recommendations of sub-committees that have dealt with the following: (1) Naturally occurring bituminous substances, (2) Distillates up to kerosenes, (3) kerosenes and intermediates, (4) lubricants, (5) liquid fuels, (6) asphaltum and artificial residues.

It is to be hoped that the invaluable work

carried out by the members of the various committees will be rewarded by the general adoption of their findings.

The Brotherhood of the Rosy Cross, by ARTHUR EDWARD WAITE. Pp. XXIII. + 649, with 16 plates. London: William Rider & Son, Cathedral House, Paternoster Row, E.C.4. 1924. 30s. net.

From the short account of the Rosicrucians in Redgrove's *Alchemy* to Mr. Waite's monumental volume of over 600 pages is a big step, and it may be asked, "What is the object of referring to such a history in *The Chemical News*?"

The answer to this is that the Rosicrucian Brotherhood exerted a considerable influence upon and was deeply connected with the early development of chemistry, or, as it was in the 17th century, alchemy.

This secret society seems to have commenced its existence and activities in Germany about 1614. although Raymond Lully, Paracelsus, John Dee, and also, indeed, Francis Bacon, have all been suggested as founders of the body. Mr. Waite, however, advances much evidence to show that the actual originator was Simon Studion.

Its public activities may be regarded as commencing with the publication, about 1614, of the *Fama Fraternitatis*, which gave an alleged account of the society's origin and invited applications for membership. In 1616, *The Chymical Nuptials of the Christian Rosenkreutz* appeared. Much of this and other writings were not only alchemical, but were also mystical and fantastic. Some were evidently intended to dupe their readers; on the other hand, the society's supporters included many learned and honest men, *e.g.*, Fludd and Maier (but they were philosophers rather than chemists), who did much to establish early scientific thought and discussion.

Mr. Waite's book on the mystery of the Rosy Cross is an exhaustive and critical survey of its objects and history.

PUBLICATIONS RECEIVED.

Production et Consommation des Engrais Chimiques dans le Monde. Pp. VIII. + 266. Rome: Imprimerie de l'Institut International d'Agriculture.

The International Institute of Agriculture, Rome, has published the third edition of *Production et Consommation des Engrais Chimiques dans le Monde*, which contains valuable statistics of the movement of chemicals and chemical products in agriculture. The compilations appear to be very complete and must have entailed considerable labour on the part of the collaborators.

Prof. E. F. Smith has written a brief biography of *Martin Hans Boye*, 1812-1909. This chemist did much more than is generally recognised in founding an American chemical school. He isolated ethyl and methyl perchlorates, and examined their explosive properties at great risk. He also had a wide knowledge of geology, mineralogy and physics, and also investigated the animal synthesis of hippuric acid.

A pamphlet entitled *The Sodium and Magnesium Salts of Western Canada*, by L. H. COLE, has been reprinted from *The Transactions of the Canadian Institute of Mining and Metallurgy*. It deals with the occurrence of the West Canadian salt deposits, and points out that production is in its infancy. An estimate of the total deposits is given, and the future prospects are stated to be very promising.

BOOKS RECEIVED.

First (Experimental) Reports to the Atmospheric Corrosion Research Committee (of the British Non-Ferrous Metals Research Association), by W. H. J. VERNON B.Sc. Pp. 839 to 984. March, 1924. The Faraday Society. Price 7s. 6d.

Electrode Reaction and Equilibria.—A GENERAL DISCUSSION. Pp. 668 to 838. November, 1923. The Faraday Society. Price 10s. 6d.

Technique of Tissue Culture "in Vitro," by T. S. P. STRANGEWAYS. Pp. VIII. + 80. 1924. Messrs. W. Heffer & Sons, 4, Petty Cury, Cambridge. Price 7s. 6d. net.

Tissue Culture in Relation to Growth and Differentiation, by T. S. P. STRANGEWAYS. Pp. X. + 50. 1924. Messrs. W. Heffer & Sons, 4, Petty Cury, Cambridge. Price 5s. net.

SCIENTIFIC BRICK MAKING.

THE USE OF BOILER ASH AND CLINKER.

The attention of science is now being directed more and more to the utilisation of the so-called waste products of industry, and a good example of this is the conversion of ash and clinker from steam boiler and other furnaces into high-grade bricks. The principle consists in mixing the ground material with a certain proportion of thoroughly slaked lime and water to form a stiff paste, passing through a brick moulding machine, and then heating in a closed chamber with steam at atmospheric pressure, which results in the production of a high-grade bluish coloured brick, something like the ordinary Staffordshire blue brick.

The extent of the grinding is equivalent to all through an 8-mesh screen for the ash and clinker, and all through a 50-mesh screen for the lime, which is added to the extent of 6-10 per cent. of the total weight. This is followed by 10-15 per cent. water, and the mixture is then treated with steam in a special mixing apparatus which gives a very even consistency. The hot thick mass is subsequently discharged into a silo or storage tank, where it is allowed to lie for 12-36 hours. The primary object of this method, that is, the grinding of the lime, the slaking both the steam and water, the thorough mixing and the use of a silo, is to make certain that the lime is completely slaked, so that there is not the slightest trace of quicklime (CaO) left, which always happens with any ordinary method of slaking lime. It is very curious that there seems to be no accurate chemical test for the presence of minute traces of free lime in slaked lime, and in fact the manufacture of bricks on these lines is much more sensitive than any ordinary test.

The necessity of special slaking in this process of brick making was first realised by Messrs. Sutcliffe, Speakman & Co., of Leigh, Lancs., who have devoted many years' work to this special branch of engineering, including sand, ash, clinker, and blast furnace slag bricks, as well as briquetting, grinding and mixing machinery, and is the essential feature on which their sand, slag, and clinker brick plant and appliances are based.

The mixture of sand and slaked lime, after maturing, has added to it any further amount of water that may be necessary, and the smooth mass is then passed continuously through the brick moulding machine, which operates at 2 tons per square inch pressure. The brick shapes so obtained are packed on trolleys, 400 bricks per trolley, and passed into a horizontal tunnel of concrete or brickwork, being then subjected for 5-6 hours to direct steam at atmospheric pressure, that is, 212° F. The chemical reaction that takes place seems to be essentially that the free silica (SiO_2), or the acid silicates in the ash and clinker, combines with the lime to form calcium silicates, which bind the whole mass into an intensely hard brick of smooth structure, something on the same lines as the action of cement in concrete. The trolleys full of bricks are then pulled out of the steamer—being replaced immediately by a fresh charge—and are ready for use almost immediately.

The process is not only cheaper than ordinary brick-making by burning clay in kilns, but the bricks themselves are superior both as regards resistance to crushing strain, absorption of water, and evenness of shape, every brick being a "facing" brick, since there is no bulging, twisting, or other distortion. Also they are equally porous to air, and the method has the great advantages that it is extremely simple and can be worked with ordinary unskilled labour. Finally, it is interesting to note that if time is no consideration, the steaming can be done away with altogether, since the same result is obtained, the formation of calcium silicates, by leaving the brick shapes in the air for two or three months, the cost of the plant, which is not excessive in any case, being in this way cut down still further. Obviously, therefore, the matter is well worthy of the serious consideration of all large stea musers, especially in view of the serious shortage and high price of bricks.

New Patents.

This list is specially compiled for *The Chemical News* by Messrs. Rayner & Co., Registered Patent Agents, of 5, Chancery Lane, London, from whom all information relating to Patents, Trade Marks, and Designs can be obtained gratuitously.

Latest Patent Applications.

12747—Menke, J. B.—Production of nitrated organic compounds. May 23.
12730—Robinson, C. S.—Production of oxides of sulphur. May 23.
13167—Collett, E.—Catalysts for synthesis of ammonia. May 29.
13253—MacKay, H. S.—Electrochemical treatment of copper ores, etc. May 29.
13345—Chemische Fabrik auf Actien vorm. E. Schering.—Manufacture of compounds of 4-amnio 2-argentomercaptobenzene-1-carboxylic acid and alkali salts thereof. May 30.

Specifications Published this Week.

215400—Coley, H. E.—Reduction of ores, oxides and the like.
215470—West, J. H., and Jaques, A.—Manufacture of ammonia compounds.
197655—Cassale, Dr. L.—Process for the synthetic production of ammonia.
215802—Edwards, G. W., and Durant, H. T.—Treatment of oxidised ores or other oxidised compounds of copper and zinc.
215813—Laporte, Ltd., B., and Alcock, H. E.—Manufacture of phosphoric acid.

Abstract Published this Week.

213991—Menthol.—Howards & Sons, Ltd., Uphall Works, Ilford, and Blagden, J. W., Apple Tree House, Grove Road, South Woodford, both in Essex.

Hydrogenated organic compounds, catalytic production of; menthol.—In the catalytic hydrogenation of thymol to form a mixture of isomers of menthol, one of which is solid and the other liquid at normal temperatures, the liquid isomer of a previous operation is employed as a solvent for the thymol to be hydrogenated. As the hydrogenation product then contains the solid and liquid isomers in substantially the same proportions as when thymol alone is hydrogenated, repetition of the process ultimately converts all the thymol into the solid menthol. In addition, if the whole hot liquid mass resulting from the hydrogenation of thymol be agitated at a temperature below the hydrogenation temperature and in the presence of a catalyst, the proportion of solid menthol obtained on subsequent cooling is greater than that obtained by mere cooling of the original hydrogenated thymol; the liquid, after separation of the solid, can be again heated and then agitated as before, and yields a further quantity of the solid isomer. Examples are given of the hydrogenation of thymol and of the transformation of the liquid into the solid menthol.

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